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THE LARYNGOSCOPE.

VOL. LXV

NOVEMBER, 1955.

No. 11

REVIEW OF THE AVAILABLE LITERATURE ON THE PHARYNX AND PHARYNGEAL SURGERY FOR 1954.*

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PHYSIOLOGY.

Cole¹ performed experiments designed to measure temperature and humidity of respiratory air. He found that samples of inspiratory air from the oropharynx contained about 25 per cent less water and were about 4°C cooler than air saturated with moisture at body temperature. The respiratory rate did not alter these figures. A body mechanism for conservation of heat and moisture is demonstrated.

In an interesting discussion Calnan² called attention to "The Error of Gustav Passavant," whose theory of velopharyngeal closure has been accepted without question for nearly a century. Passavant's life is briefly reviewed, and his presentation on "closure of the pharynx in speech" is critically analyzed. There was no clear concept of the action of the soft palate until Passavant presented his classical paper in 1869.

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To him must be given the credit for showing that the velum is a muscular structure which moves in a definite way.

Passavant advanced the theory that the annular bulging of the posterior pharyngeal wall caused by the bulging of the superior constrictor masseter, just slightly above the level of the velum, causes the palate flap which is essential for intelligible speech. Support for Passavant's theory was given by Browne, Oldfield, Dorrance, Wardill and Stein, whereas objections were voiced by van Lushka, Victor Veau, Borel-Maissonny and Wood-Jones. Five additional objections are advanced by Calnan based on clinical and radiologic evidence. That Passavant's ridge can and does occur in association with cleft palate is recognized; that it is a factor in normal speech is vigorously denied by Calnan.

PATHOLOGY.

Semenov³ presented a thorough, interesting study of the pathology of the pharyngeal recess, Eustachian tubes, tonsils and adenoids. He pointed out that the fossa of Rosenmueller, a deep pocket in the uppermost corner of the nasopharynx, is in addition a hidden trap: first, because of its great depth; second, because it contains a mass of adenoid tissue; third, because malignant growths arising in this location metastasize quickly; fourth, because cryptic infection is more common here than is generally supposed, and finally, because this is the origin of many colds and nasopharyngeal infections.

The histology, physiology and applied pathology of the nasopharynx, Eustachian tubes, tonsils and adenoids are well discussed. The problem of irradiation of the nasopharynx and the microscopic examination of the irradiated tissue is well presented. Semenov agreed that a good adenoid operation is difficult to perform and stated that adenoid tags are more common than tonsillar tags. Adenoids occur in adults as well as in children and they should be removed when they cause signs and symptoms of disease. Semenov posed an interesting question. A million or more tonsillectomies are performed in the United States every year. If a single tonsil weighs 3 Gm. and an adenoid 2 Gm., how many pounds or even tons of lymphoid tissue are removed during our lifetime? This is a well il-

illustrated and prepared article which cannot be easily summarized. To appreciate it one must read it in its entirety.

BACTERIOLOGY.

Goldman and associates⁴ made a study of the nasal flora in 50 normal children and in 50 children with nasal infections. They noted that cultures taken from the nose and nasopharynx of children showed the same nonpathogens as those from adults. In disease, cultures from children also corresponded to those from adults. The nasopharynx of children harbors pathologic organisms which under certain circumstances lead to sinusitis or laryngotracheo-bronchitis.

The aerobic flora of the nasopharynx and stools were studied by Stoppelman and Schwachman⁵ in 140 patients with mucoviscidosis who had received antibiotic therapy continuously for a period of as long as six years. These observations confirm previous conclusions that despite the resistance in the nasopharynx to antibiotic therapy, satisfactory clinical response may still be obtained.

DIAGNOSIS.

Fletcher and associates⁶ described a supplemental aid to clinical examination of the laryngopharynx which may be of particular value in determining the site of origin of tumors in this region. Invasion and perforation of the thyroid cartilage, and extension of the tumor into the pre-epiglottic space cannot be determined by indirect laryngoscopy but may be readily discovered by radiologic examination. The latter might also be helpful when edema and the tumor prevent visualization of such structures as the pyriform fossa and subglottic space. A lateral soft tissue view and tomographic frontal sections of the laryngeal region form the basis for three dimensional study of the larynx *in situ*.

Topography is particularly useful in the following conditions: 1. Ulceration of the epiglottis and invasion of the pre-epiglottic fossa (which makes panlaryngectomy mandatory). 2. Destruction of the thyroid cartilage, which may be manifested by disorganization of the calcification pattern of the thyroid cartilage. These calcifications are normally very ir-

regular, and less extensive in females than males. This, together with other factors, must be considered when interpreting the roentgenograms. Cartilaginous destruction makes postoperative Roentgen-ray therapy imperative. 3. Subglottic extension, which is demonstrable on the tomogram and may show active subglottic disease in cases in which this area cannot be visualized by indirect or direct means because of an anterior (postoperative laryngofissure) web, overhanging tumors or edema.

Fletcher and associates classified laryngopharyngeal tumors according to site of origin: 1. Endolaryngeal; 2. brim of laryngeal inlet and, 3. pyriform sinus. They believed this important because of the variations in biologic behavior of tumors originating at different anatomic sites. Accurate determination of the site of origin leads to a more intelligent therapeutic approach. Tomograms, by showing tumor extension, may provide the clue to site of origin in difficult cases, particularly in extensive growths.

O'Bannon and Grunow⁷ pointed out that radiographic examination of the larynx and pharynx is a simple procedure, requiring no special apparatus or inconvenience to the patient; moreover, much may be gained from this type of examination to substantiate the clinical findings and to aid in diagnosis. The authors also made radiographic examinations as a means of determining sex, age of ossification and ossification centers, but nothing special could be concluded in this regard. They theorized that ossification begins in persons early in the second decade of life, and the pattern is inherited and individual in each person.

DISEASES.

Ozena and rhinitis sicca were treated by Standbygard⁸ with large doses of vitamin A. The preparations used were Arovit (Hoffmann-LaRoche) in ampoules with 1 cc. of oil suspension containing 300,000 I.U. and tablets of 50,000 I.U.; 300,000 I.U. was given twice weekly and 0 to 4 tablets were given during intervals. Of 35 patients thus treated 27 were rendered asymptomatic in two to three months. Nine cases are reported in which the response to Arovit therapy was favor-

able. There were three additional patients whose disease proved refractory to this treatment.

Eberhart and Socarides⁹ are convinced that angioneurotic edema of the pharynx is caused by psychologic factors. They reported a case of swelling of the larynx and pharynx following emotional disturbances. Conflict of personalities with superiors invariably brought on fullness and choking sensations. This responded satisfactorily to administration of epinephrine and ephedrine, and also to the antihistaminic drugs if taken early in the attack. The authors found that psychotherapy through reassurance served to ward off attacks for one and one-half years. Allergic studies yielded negative results, and although psychotherapy has not eliminated all attacks, it has reduced and minimized them considerably.

Stoppelman¹⁰ conducted a study of the effect of antibiotics on the nasopharyngeal flora of premature infants, while the Infants' Hospital in 1948 inaugurated a method of therapy whereby every premature infant admitted was routinely given penicillin, and either sulfadiazine or streptomycin in relatively large doses for the first five or ten days following admission. The effect upon mortality appears to have been favorable.

A similar regimen was conducted simultaneously at the Boston Lying-in Hospital. Cultures from the nose and throat were frequently sterile for the first 24 hours after birth. Routine cultures were obtained from the nasopharynx on the first, third, fifth and tenth days. A significant reduction in the incidence of streptococci was noted, whereas staphylococci were unaffected. It is difficult to evaluate this study, as reports on findings in normal infants are completely ignored.

Tamari and Orrico¹¹ reported two cases of infection of the pharynx with abscess which occurred in children of the same mother but different fathers. The infection in the middle ear and the complications began in both children almost at the same age, and the complications in both were similar. The authors believed that spread of the infection toward the pharynx in both cases probably was induced by progression of the inflammation along the bony and cartilaginous wall of the Eustachian tube. The retropharyngeal abscess probably developed along the lymphatics of the parotid gland fascia and

extended to the pharyngo-maxillary space by way of the pterygoid facial compartment.

Norris and Armstrong¹² presented a most unusual and interesting case of membranous cryptococcic nasopharyngitis. Cryptococcosis may produce pulmonary infections, deep seated abscesses, cutaneous lesions, and frequently in Southern countries low grade fatal meningitis. According to the authors the condition is also known as torulosis, or European blastomycosis, and a Busse-Buschke disease.

Norris and Armstrong stated that we are now seeing more and more patients suffering from fungous infections, and this is thought to be due possibly to the prolonged use of antibiotics. A case is presented which is thought to be the first reported case of its kind. The patient had a low grade fever and painful throat. Examination disclosed a creamy, jelly-like membrane involving the uvula and nasopharynx. Cultures established the diagnosis. Local applications of gentian violet and hexylresorcinol and administration of achromycin and potassium iodide gradually cleared up the stubborn infection. In addition, the patient had eight intramuscular injections of bismuth salicylate in oil with chlorobutanol. The authors suggested use of similar medication in similar cases, and believed that such therapy might well be life-saving agents.

Parrott and associates¹³ described an illness characterized by pharyngitis, rhinitis, fever, cervical or submandibular lymphadenopathy, conjunctival inflammation and hepatic tenderness, which occurred in four children and four adults among the patients and staff of a hospital service. This infection of adenoidal, pharyngeal, conjunctival virus, type 3, was contracted by these people shortly after a child was admitted to the service with this disease.

Morse and associates¹⁴ described a method of production of group A streptococcal pharyngeal infections in rabbits which affords another means of studying effects of repeated group A infections under conditions similar to those that occur in man. They observed that after intrapharyngeal inoculation, transient bacteremia usually occurred, followed by fever to 48 hours, and significant rises in ASO titers one month later. Bacteria were found in pharyngeal tissue at 48 hours, and

small abscesses developed in some instances. McMath and Pereira¹⁵ reported a case of fatal rupture of a retropharyngo-esophageal abscess in a previously healthy 10-year-old girl. The child was hospitalized after an illness of one week, which had been diagnosed as acute pharyngitis with severe cervical lymphadenitis. Eight hours after admission the child suddenly became cyanotic, stopped breathing and died, despite tracheotomy and other resuscitative measures. Autopsy revealed an extensive abscess involving the posterior pharyngeal wall from the uvula down to the arch of the aorta. Rupture had been into the pharynx with flooding of the trachea and bronchi with pus. No evidence of a foreign body was found.

In recent years fluoroscopic and radiographic studies of the movements and contractions during the act of swallowing have been undertaken with increasing frequency. From a diagnostic, prognostic and therapeutic point of view this method is increasing in value and fame. Thulin and Welin¹⁶ reported three cases of unilateral hypopharyngeal paralysis, studied radiographically. All showed typical changes of filling and stretching of the hypopharynx on that side; however, the cause of the paralysis cannot be determined from this type of examination and, therefore, direct examination should be done in all cases.

Fisher¹⁷ noted the frequent occurrence of adhesions in the fossa of Rosenmuller. These produce postnasal drip, weariness between the eyes, inability to concentrate, and nasal fullness and obstruction. Relief of these symptoms is obtained by breaking up these adhesions. Several interesting cases are cited.

ATRESIA.

McDonald¹⁸ reported two cases of atresia of the nasopharynx, one resulting from infection and ulceration followed by adhesions and scarring and the other from tonsillectomy and adenoidectomy. He employed the MacKenty procedure with good results in both cases.

DIVERTICULA.

Slade¹⁹ reported three cases of peptic ulcer occurring in association with pharyngeal diverticula. No previous reference

to this association has been found in the literature. None of the patients was cured following operation for peptic ulcer until the diverticula were also corrected.

Jesberg²⁰ stated that there are few subjects in medicine in which there has been as much confusion, perpetuated inaccuracy and misinformation as pulsion diverticulum of the hypopharynx. That a pulsion diverticulum in this region should be considered as a lesion of the esophagus is anatomically erroneous, according to Jesberg. He even objected to the terminology of pharyngo-esophageal diverticulum. He thoroughly reviewed the literature and made appropriate comments regarding it.

He then reported an interesting case of a bilobed diverticulum of the hypopharynx which was successfully excised. At operation no reason could be found for the variation in the shape of the diverticulum. The diverticulum opened anteriorly and to the right of the esophagus. This is at variance with the usual area from which diverticula develop. In all that we have seen or read about diverticula, they invariably developed on the posterior pharyngeal wall in a triangular area formed by the oblique fibers of the inferior constrictor of the pharynx and the orbicular fibers of the cricopharyngeus muscle; therefore, the diverticulum is also unusual because of its origin, which is different from other reported cases.

According to Wiig²¹, pharyngo-esophageal diverticula are three times more common in males than females, and occur more often in those past the age of 50 years. He reviewed this condition and reported three cases, which were successfully corrected by the one-stage technique. Wiig removes the Levine tube on the seventh day, because he fears that it will cause pressure necrosis at the suture line. It is our opinion that an indwelling tube can be safely removed on the fifth or sixth day, and we have not seen any cases of necrosis resulting from pressure of the tube.

FOREIGN BODY.

T'Ang²² reported an unusual case of a foreign body in the nasopharynx of a 15-month-old baby. The foreign body was a Chinese thimble, which is a wide metallic ring with proper

indentations. Two months prior to discovery of this foreign body the parents suspected the child had swallowed the object. Roentgenograms of the entire gastrointestinal tract at that time revealed no evidence of foreign body. Bilateral otorrhea stimulated further examination, and it was noted the soft palate was pushed forward slightly. Mirror examination of the nasopharynx disclosed the foreign body, which was removed without difficulty.

Arnold and Som²² reported an interesting case of a foreign body lodged in the posterior pharyngeal wall at the level of the third vertebra. A stabbing pain in the throat indicated the object was sharp, and dysphagia and dyspnea soon developed. Roentgenography showed a metallic wire-like foreign body 1.5 inches long extending transversely across the pharynx. Better roentgenologic localization was obtained by attaching Michel clips to the posterior pharyngeal wall in the locality where the foreign body was suspected. Arnold and Som stated that without use of the suspension laryngoscope, removal of the foreign body would have been extremely difficult.

INJURIES.

Birsner and Leask²⁴ pointed out that the significance of swelling of the retropharyngeal soft tissues in the presence of fractures and/or dislocations of the cervical spine has been stressed, but that swelling of the retropharyngeal soft tissues due to "whiplash" injury without radiographic evidence of fracture and/or dislocation has not previously been reported. The "whiplash" injury is usually incurred from automobile accidents and is due to sudden deceleration.

Birsner and Leask briefly reviewed the normal limits of soft tissue spaces of the neck and reported nine cases of severe swelling of the retropharyngeal soft tissues due to "whiplash" injury. Their observations indicate that the thickness of the retropharyngeal soft tissues may be of value in further determining the exact degree of trauma both to the soft tissues and to the bony component of the cervical spine. Swelling in this area is of particular importance in the absence of radiographic evidence of fracture, and is indicative of hemorrhage or edema.

Birsner and Leask indicated that routine roentgenograms of the cervical spine should be made in all patients with severe injuries to the neck, and if there is any indication of swelling of the retropharyngeal soft tissues, a second lateral view should be taken in 24 hours. This is important, as radiographic findings indicate this type of injury might be related to late degenerative changes in the cervical discs and that it may also be a causative factor in the formation of osteophytes which are so characteristic of late results of trauma. Since swelling of the retropharyngeal soft tissues occurs in the absence of fractures, it may be the only concrete evidence of injury. It would, therefore, be an index to the degree of trauma and of major importance from the medicolegal aspect.

ROENTGENTHERAPY.

Bordley²⁵ advocated the practice of more and more preventive medicine, especially in school children 8 to 13 years of age. Children showing a decrease in hearing have been greatly benefited by use of nasopharyngeal irradiation. This is used only in children showing regrowth of adenoid or lymphoid tissue about the orifice of the Eustachian tube. Large central adenoid masses should be removed.

Meltzer²⁶ discussed the histology, physiology, anatomy and pathology, as well as the endocrinologic aspects of recurrence of lymphoid tissue. He presented arguments in favor of and against irradiation and radium. He concluded that surgical treatment often repeated, followed by irradiation and, if indicated, allergy studies, offers the best chances of return of hearing in patients with blockage of the Eustachian tube by lymphoid tissue.

Hardy and Bordley²⁷ made a controlled study on the effect of nasopharyngeal irradiation in about 5,428 children. After five years 385 of the original 582 in the study group were reexamined to determine the effectiveness of radiation, to study the changes in hearing acuity, and to study the effects of puberty on lymphoid growth. There was evidence that irradiation reduces lymphoid tissue. The gain in hearing was more noticeable in the treated than in the control group. At puberty improvement in hearing takes place, which is due to change in the condition of the lymphoid tissue.

It is well known that patients exposed to radiation who are not properly protected are subject to radiation cancer. Raven and Levison²⁸ reported a case of radiation cancer of the hypopharynx following radiotherapy for thyrotoxicosis.

SURGERY.

Beavis²⁹ considered one of the most controversial problems of all times to be the reconstructive management of clefts of the muscular velopharynx. He reviewed the history of cleft velum from earliest literature, and attempted to select those methods which have the most practical application. The palatopharyngeal muscular mechanism is an extremely intricate one, and this anatomic area is well discussed. Adequate illustrations help to describe the surgical procedure most practical in the reconstruction of palatal defects. This is one of the best presentations of a difficult subject. The results obtained warrant the meticulous care and study of the subject matter. The development in practical treatment of split palate and velopharynx from 1013 to 1946 is given.

DeLisa³⁰ proudly stated that he had had no cases of post-operative hemorrhage following adenoidectomies since he began irrigating the nasopharynx with cold saline solution at the conclusion of the operation. With the suction tip in the pharynx, both nostrils are flushed with a 60°F. saline solution. This irrigation is repeated until complete hemostasis is obtained. Incomplete removal of tissue is the commonest cause of postoperative hemorrhage.

Goligher and Robin³¹ devised a technique elevating the mobilized left colon to the upper pharyngeal remnant after pharyngectomy. They advocated freeing the colon in two stages. They reported a case in which antethoracic esophagopharyngoplasty, using the left colon, was successfully employed to restore continuity with the stomach after pharyngectomy for carcinoma of the pharynx. In a good summary of the literature they mentioned the Trotter and Wookey operations as well as those of Harrison, Robertson and Sargent.

BENIGN TUMORS.

Martin³² presented a general discussion of the main facts known about nasopharyngeal fibroma, and discussed patho-

logic and clinical features. He believed that surgical treatment has been retarded for lack of a useful approach to the tumor. He considered the transpalatal approach satisfactory in most cases. It is still difficult to remove the tumor by this approach, but it is the best available approach. Martin thought that diathermy removal of as much of the tumor as possible by this route may prove to be an important advance in the management of these patients. In excessively vascular tumors which have been incompletely removed, Martin advocated the palatal fenestration operation without delay. The technique is described.

Kremen³³ presented a new surgical approach for the management of nasopharyngeal fibromas. These tumors occur mostly in young pubescent males producing symptoms of nasal obstruction, vocal and auditory changes and dangerous bleeding. They grow progressively through adolescence, and after maturity the vascular channels become obliterated and the tumor regresses. Recurring hemorrhages and expansion of the tumor force these patients to seek relief. The various methods of therapy are briefly reviewed, and the conclusion is reached that none are entirely satisfactory.

For this reason Kremen devised a new approach in which a vertical incision is made in front of the ear and down the neck anterior to the sternocleidomastoid muscle, and then a horizontal incision is made beneath the angle of the mandible joining the vertical incision. The external carotid is ligated and the lower pole of the parotid gland is dissected free. The masseter muscle is severed and the mandible is transected one centimeter below the notch formed by the coronoid and condyloid processes. Blind dissection is carried through the internal pterygoid muscle, and the tubulomuscular wall of the nasopharynx is incised longitudinally on its lateral wall to expose the tumor. The tumor is then removed, and bleeding is controlled by packing, and in closing, the edges of the mandible are wired together. Kremen reported two cases successfully treated by this technique.

The author deserves credit for the ingenuity of devising this approach, which undoubtedly has merit. The approach

seems to be radical considering that less formidable operative procedures have proved successful through the years.

From a study of 25 cases of juvenile nasopharyngeal angiofibromas Sternberg³⁴ found that though these tumors have a variable histologic pattern, they have an underlying basic vascular structure. The cause of these tumors is not known, but Sternberg believed that they are probably influenced by some as yet unknown endocrine factor. He based this view on the fact that nearly all angiofibromas occur during adolescence, there are rare instances of spontaneous regression, and they occurred only in males in his series.

Gundrum, Stambuck and Gaines³⁵ reported a case of choristoma of the nasopharynx, and perusal of the literature failed to show a similar reported case. This tumor in a newborn infant produced obstruction to nasal breathing and swallowing. On examination a grayish movable mass was found in the nasopharynx and was easily removed surgically.

Gundrum and associates believed, as do several others, that this type of tumor "represents a displacement of tissues in the course of development, so that they appear in a neighboring area." If this is correct, they conclude that choristomas are true neoplasms; however, in his original description of the lesion Albrecht described the choristoma as a misplaced anlage, and did not believe it to be a true tumor.

Stewart³⁶ reported a rare case of neurofibroma of the pharynx with other neurofibromas of the neck and left leg.

Hemley, Schwinger and Friedman³⁷ described juvenile nasopharyngeal angiofibroma as a distinct clinical entity almost exclusively limited to adolescent males. It is an active fibrovascular tumor, pathologically benign in spite of having the ability to erode. The extreme vascularity of these tumors is responsible for the fact that epistaxis is the most common complaint. Because of this vascularity, operation is always hazardous, and radiation is frequently employed to help decrease the vascularity of the tumor. The authors advocated the use of androgens with the hope that the sexual maturity thus induced might decrease the vascularity of the tumor. The tumor tends to regress with adult life. The prognosis as to life is excellent.

Unilateral branchiogenic nasopharyngeal cysts are rare, and bilateral ones have not been heretofore reported. Taylor and Burwell³⁸ reported two cases each of unilateral and bilateral branchiogenic nasopharyngeal cysts. The question of their branchiogenic origin and embryologic derivation is discussed at length. Good results followed treatment consisting of injecting the cysts with a sclerosing solution.

Handousa and coworkers³⁹ reported their experience with 70 cases of nasopharyngeal fibroma, which is the commonest benign growth found in the nasopharynx. They estimated the incidence of nasopharyngeal fibromas in Egypt to be one in 50,000 patients, which is less than that reported for other countries. A good discussion of the origin, extension, symptoms and treatment is given.

Handousa and associates are not in agreement with the opinion of some that spontaneous regression occurs uniformly at the time of sexual maturity. They did, however, agree that irradiation reduces the vascularity and size of the tumor. They advocated surgical excision, believing that the dangers of the operation have really been over-estimated; however, in the next paragraph they stated that at operation hemorrhage can be so profuse as to be fatal. Moore's lateral rhinotomy approach was used by choice, and excellent results are reported.

Pathologists have long been concerned with the etiology and pathogenesis of the various lymphoid diseases. According to Friedberg and Hass⁴⁰, the initial manifestation of certain lymphoid disorders may be a tumor of the nasopharynx or pharynx. The finding of any abnormal or recurrent mass of lymphoid tissue in the nasopharynx, of a smooth unilateral swelling of the lateral pharyngeal wall, or unilateral tonsillar hypertrophy should arouse suspicion as to the possibility of a lymphoma. Friedberg and Hass reported 10 cases of lymphomas in detail, with interesting comments following each case report. They expressed the opinion that an accurate diagnosis can be established only by biopsy, and if cervical node enlargement exists it is highly desirable to obtain one for examination. In all their cases irradiation was used, and in some it proved to be of great benefit.

In an excellent discussion Dane⁴¹ agreed that the etiology of nasopharyngeal fibroma is still unsolved and reviewed several theories previously advanced. The symptoms and clinical course of these tumors are described. It is unanimously agreed that only patients with definite symptoms should be treated. The rich venous supply of these tumors serves as a constant threat of serious hemorrhage so that many clinicians are hesitant even to perform biopsy. Radiation therapy and interstitial radium application serve to reduce the size of the mass. Surgical removal is accomplished when necessary, and the approaches and methods are discussed. This article, however, deals primarily with a case of regression of a nasopharyngeal fibroma. In such tumors, when there is evidence of regression, conservative therapy, consisting of androgenic hormones, anti-anemic measures, vitamins, radiation therapy, interstitial radiation and electrocoagulation, has proved most valuable.

Schindler, Hurwitz and Greenwood⁴² reported a case of teratoid tumor in the nasopharynx of a newborn because it is a rather rare tumor occurring in an unusual location and in an unusually young patient. At the first feeding the infant experienced difficulty in swallowing and became cyanotic. Investigation disclosed a pedunculated tumor attached high in the nasopharynx. This was successfully removed by means of a snare.

MALIGNANT TUMORS.

Lederman⁴³ described the pharynx as extending from the base of the skull to the esophagus, and stated that it is probably one of the largest and most important sphincters of the body. It provides a common channel for passage of air and food from the exterior to the respiratory and digestive tracts, respectively. There is agreement as to the anatomic subdivisions of the pharynx, but there appears to be little agreement as to the terms used to describe these subdivisions.

Lederman gave a summary of the classifications of tumors of the laryngopharynx proposed by some well known authors, which is most interesting but confusing. To add further to the confusion the classification used at the Royal Cancer Hospital in London, with which he is associated, was described minutely.

There is no question as to its merit, particularly if it were generally accepted.

Lederman placed much value on the proper "staging" of tumors of the laryngopharynx, the obvious advantage being that a sound basis is provided for prognosis and for comparing and assessing results of different methods of treatment. He proposed three possible ways in which laryngopharyngeal tumors can be "staged." A single method to cover all groups is described and adequately illustrated. About 417 cases of laryngopharyngeal tumors, seen over a period of 20 years, were reviewed from the standpoint of chief clinical features and salient points in the history. Teleradium treatment was used when possible, and the survival rate was 19 per cent for three years and 13 per cent for five years. This is an excellent article which represents a great deal of research and is well worth the time of all interested in these types of tumors.

Epstein⁴⁴ reminds us that nasopharyngeal tumors usually occur as epidermoid or undifferentiated carcinomas, lympho-epitheliomas or lymphosarcomas. Nasopharyngeal tumors are slow in producing discomfort and usually are manifested by nasal obstruction, bleeding, impaired hearing, localized pain and metastasis to the cervical lymph nodes.

Epstein reported a case of nasopharyngeal fibrosarcoma in a patient who had no nasal symptoms and no cervical lymph nodes. The clinical picture was one of a posterior fossa tumor with no evidence of increased intracranial pressure. There was impairment of the third, fourth, fifth, sixth, seventh, eighth and probably twelfth cranial nerves. Ventriculography indicated invasion of the right cerebellopontine angle. Necropsy disclosed a completely unsuspected tumor of the posterior wall of the nasopharynx which had perforated in the dorsum sellae, the clivus and the overlying dura. The tumor perforated the basi-occiput and extended as a large encapsulated intradural mass to the right cerebellopontine angle. It produced a clinical picture of an atypical mass in the posterior fossa and a roentgenologic picture of an angle tumor without any visible changes in the bone.

In an excellent article discussing malignancies of the pharynx, larynx and cervical esophagus, Hilger and associ-

ates⁴⁵ stated that carcinoma of the hypopharynx has the least favorable outlook for permanent cure. Hypopharyngeal carcinomas present real problems and are best managed by performing pharyngectomy in conjunction with neck dissection. In certain extensive cases skin flaps and tubes are utilized in second procedures to re-establish normal function. Such procedures offer much higher hopes of cure than does radiation.

In an interesting article discussing sex difference in prognosis following radiotherapy for carcinoma of the pharynx, Russell⁴⁶ reported 550 cases with a ten-year survival evaluation. His analysis shows that results of radiotherapy in females are much better and the postoperative mortality rate, recurrence rate, and incidence of secondary involvement of lymph nodes are lower than in males. He further found that in all directions explored the same trend emerged in support of the thesis that response to treatment is much better in women than in men.

Antoniazzi and coworkers⁴⁷ concluded from a study of the problem of radiation treatment of secondary malignant cervical lymph node metastases from carcinoma of the pharynx that radiation therapy is successful in the metastatic glands if the tumors are radiosensitive. They prefer radical surgical treatment whenever possible. They pointed out that sterilization of cancer cells is not always achieved even when high doses of radiation are given. The fact that palpable glands persist following radiation does not always mean that metastasis persists. This can be proved only by biopsy. Radical surgical treatment is usually possible after high dosage radiation, providing therapy has been carefully carried out and the operation performed a short time after termination of radiotherapy.

Knowles and Huggill⁴⁸ discussed the origin, classification and microscopic appearance of liposarcomas. The commonest sites of origin are the lower limb, gluteal region and retroperitoneal tissues. Their origin in the head and neck is less common. These authors doubt that any of the previously reported cases in children actually represented true liposarcomas.

They reported a case in the right side of the neck in a 12-

year-old boy. Despite two courses of penicillin, the tumor slowly but steadily enlarged and soon produced fullness in the right posterolateral pharyngeal wall. Biopsies from both sites proved the diagnosis. The lesion did not respond to radiotherapy. Metastasis occurred through the blood stream, and the child died exactly one year after the first symptom. Postmortem examination revealed an ill-defined tumor of the neck, with such extensive involvement of the soft tissues of the neck as to make determination of the site of origin impossible. In addition, there was metastasis to lungs, liver, brain and the middle ear.

A sarcoma arising in adipose tissue is not necessarily a liposarcoma. Conversely, a clearly recognizable liposarcoma has not necessarily arisen from either mature or immature fat cells. There is no general agreement on the origin or microscopic appearance of lipoblasts. The obscurities in the knowledge of the origin, development and varieties of adipose tissue are clearly shown in the attempts to diagnose and distinguish different types of liposarcoma. A diagnosis of liposarcoma can be definitely established only by the observation of a complete range of intermediate forms between undifferentiated sarcoma cells and well developed fat cells of either the uniglobular or the multiglobular type.

Asherson⁴⁹ reported a case of postcricoid carcinoma in which the pharynx was reconstructed by using the mucous lining of the larynx and trachea to form the anterior wall of the esophagus. This was done in one stage, and although a fistula formed, the duration of hospitalization was greatly reduced compared to the two stage operation.

Jernstrom⁵⁰ stated that synovial sarcomas are rare, highly specialized, histologically unique malignant neoplasms of mesothelial origin. A survey of the literature failed to disclose a previously published case of synovial sarcoma located in the pharynx. Such a case is reported in a 21-year-old man who complained of a mass in his throat, followed by gradual development of dyspnea and dysphagia. This mass was firm and unattached to the mucosa but fixed to structures deep in the left hypopharynx. The precise source of the tumor was uncertain, even at autopsy. Comment was made on resem-

blance of synovial sarcoma and hemangio-endothelioma. This article contains excellent microphotographs. Jernstrom called attention to two sharply contrasted types of tissue seen in the histologic picture. One shows synovial structures and the other fibromatous elements similar to fibrosarcoma. These two components are inextricably commingled.

Miller and Davis⁵¹ presented a case of primary squamous carcinoma of the hypopharynx with metastases, associated with acanthosis nigricans of the skin, because they were unable to find a similar case in the literature. Acanthosis nigricans is usually associated with adenocarcinoma rather than squamous carcinoma, as in the case presented. The patient had had a known squamous carcinoma in the hypopharynx for five years before the acanthosis nigricans developed. The important clinical features of this disease are discussed.

In a discussion of the surgical treatment of carcinoma of the hypopharynx Raven⁵² stressed the importance of assessment of operability in each case. After discussing the various types of cases he described the radical technique which he employs in the management of carcinoma of the larynx, hypopharynx and esophagus. These structures, together with the regional lymph nodes, are removed in a monoblock operation. This is an excellent, well illustrated article plagued, however, with excessive use of the pronoun I.

Tsukamoto and Tazaki⁵³ sounded a warning against excessive use of irradiation. They reported four cases of hypopharyngeal carcinoma which developed 20 years after these patients had received extensive irradiation to the cervical region for tuberculous lymphadenitis. It is of further interest to note that carcinoma of the hypopharynx occurred more frequently in females.

According to Hara,⁵⁴ malignant tumors of the nasopharynx constitute from one to three per cent of all malignancies in this country, eight per cent in Great Britain and 18 per cent in Hong Kong. The Chinese, particularly those from the southern province of China, have shown strong susceptibility. Hara reported 33 cases of nasopharyngeal malignancies, squamous cell carcinoma being the most frequent type. Because of the

diversified pattern of the initial symptoms, the primary site of the growth often remains undetected until development of secondary lesions in the adjacent structures, occurrence of metastasis, or mechanical obstruction.

Irradiation is considered the treatment of choice for carcinomas and sarcomas; if there is no osseous involvement, nearly 40 per cent salvage can be expected, whereas when bone is involved the salvage rate is reduced to 10 per cent. Surgical extirpation in conjunction with radiation is advocated in cases of fibrosarcoma, adenocarcinoma and sometimes lymphoma.

Hara described, illustrated and used a transpalatine approach, which is adequate for surgical removal of the tumor, and he expressed gratification with results obtained. The illustrations accompanying this article and the description of the surgical approach should be studied by all interested in these intriguing problems. It is interesting to note that in our experience, lymphosarcomas have predominated, and our records show that response to radiation has been encouraging.

Kaplan⁵⁵ expressed the belief that treatment of cancer of the mouth with cervical metastasis, or cancer of the mouth which is radioresistant, by commando or modified commando procedure will increase the salvage perhaps 30 per cent, and provide amelioration in many uncontrolled cases.

In a discussion of the treatment of pharyngeal cancer by a number of participants, Morfit⁵⁶ stated that the change by his group to surgical treatment in preference to radiation therapy appears justified on the basis of the unanimously poor results achieved by radiation over the past 40 years. According to Hayes Martin the cure rate at Memorial Hospital has more than doubled (30 per cent) following change from radiation to radical surgical therapy.

The operation employed by Morfit consists of radical neck dissection with sacrifice of the larynx and a portion of the pharyngeal wall or base of the tongue. Since cancer of the hypopharynx occurs mostly among patients in the middle and later decades of life, the occurrence of associated diseases such as diabetes, hypertension and cardiovascular conditions, may be expected in a significant number of patients. None

of these complications, however, is considered a contraindication to operation.

Baclesse⁵⁶ stressed the value of radiographic localization of tumors of the rhinopharynx. Specialized radiographic techniques make possible more exact classification of the different varieties of tumors, and in many instances the extent of spread of the tumor can be determined. This information is useful in selecting the method of treatment and in determining prognosis.

LeRoux-Robert and Ennuyer⁵⁶ discussed the "en sandwich" technique of treatment of tumors of the hypopharynx. This method consists of initial radiation, surgical extirpation and further radiation. The authors stated that the "en sandwich" technique is used in cases in which the primary tumor is too extensive for immediate operation, when there is severe adenopathy, and in patients with far advanced disease.

Vieira⁵⁶ reported results of intensive radiation therapy in 31 patients with nasopharyngeal cancer. Six additional patients received no treatment because of the advanced stage of the disease. Five of the 31 patients treated, or 16 per cent, survived five years without symptoms.

Towson⁵⁷ correctly warned that any tumor found in the nasopharynx should be suspected of being malignant until proved otherwise. He reported a case of reticulum cell lymphosarcoma of the nasopharynx. The initial symptom was blockage of the nasal passages. The tumor disappeared completely following irradiation, and six years later the patient succumbed to coronary thrombosis.

Horwitz and coauthors⁵⁸ emphasized the fact that irradiation therapy of carcinoma of the hypopharynx has not proved successful in the past. The recent advances in medicine and the vast improvement in preoperative care of the patient now permit surgical attack of carcinoma of the hypopharynx with promise of a much higher percentage of five year cures. Unilateral or bilateral neck dissection in continuity with laryngopharyngectomy, although radical, is nevertheless life saving.

The authors pointed out that early surgical action, when possible, offers the greatest chance for survival. It is pleasing to note that a plea is made for early rehabilitation of those patients who have had extensive and mutilating surgical procedures. Too often this important phase of therapy is sadly neglected or even ignored.

The high incidence of nasopharyngeal carcinomas occurring in Chinese (18 per cent of all cancer cases) prompted an investigation by Das and associates⁵⁹ in an effort to determine whether this disease had a predilection for Orientals. Their study extended over a period of three years. They were able to show definitely that the incidence of nasopharyngeal carcinoma in India is about 1.7 per cent of all cases of cancer. This corresponds favorably with figures from American hospitals.

They then concluded that the disease has no predilection for Orientals. Emphasis is placed on diagnostic difficulties, and the fact that early symptoms are seldom present. Sixty per cent of the 16 patients studied had cervical metastasis. It was concluded that roentgentherapy offered the best chance for survival, particularly if the case was an early one. Headaches and bloody expectoration were probably the most frequent symptoms. Because of inaccessibility of the region involved, and the absence of pain in the early stages, diagnosis is delayed.

Kiem⁶⁰ expressed the opinion that carcinoma of the vallecula makes its presence known early because of early discomfort and pain produced by the lesion. Early lesions are at times difficult to diagnose, as the variation in the structure of the epiglottis and the base of the tongue is such as to make visualization of the vallecula difficult. Although Kiem stated that he has seen 342 cases of carcinoma of the vallecula, he reported only two cases and stated that in 64 (18.7 per cent) the vallecula could not be seen easily. In such cases, displacing the tip of the epiglottis backwards is necessary in order to see the vallecula and obtain a biopsy. Preference is expressed for the anterior pharyngotomy route, which consists of an incision at the level of the hyoid bone. The technique is well described, and satisfaction is expressed with the results obtained.

Mekie and Lawley⁶¹, practicing in Singapore, are enviably located to study nasopharyngeal carcinoma. They stated that nasopharyngeal carcinoma is the third commonest type of carcinoma seen in Singapore, and the second commonest seen in Hong Kong. They made a clinical study of 120 cases of nasopharyngeal carcinoma encountered from 1947 to 1953. Their conclusions are in agreement with those of others that males are affected three times as often as females, and the initial complaint is most commonly enlargement of the cervical lymph nodes; however, among the main symptoms of their patients were the usual ones, such as epistaxis, nasal obstruction, headache and deafness.

In 45 per cent of the patients the cranial nerve was involved, the most frequent being the sixth nerve. Radiologic evidence of destruction of cranial bone by the tumor was evident in a fairly large group of cases, and erosion of the floor of the middle cranial fossa and the sella turcica, and opacity of the sphenoid were common signs of intracranial involvement. Mekie and Lawley plan to publish other reports based on this study. With the environment enjoyed, careful analysis and scientific observation should make these future reports valuable.

Batory⁶² emphasized the fact that lymphoepithelioma of the nasopharynx is not only uncommonly encountered in childhood, but it is difficult to diagnose in its early stages if adenoids are still present. She reported such a case occurring in a five-year-old child, whose first symptom was cervical adenopathy. These enlarged glands were first thought to be secondary to enlarged tonsils; however, their continued growth prompted more thorough examination, which disclosed a greyish mass in the nasopharynx. Biopsy soon disclosed the nature of the growth and radiation was instituted.

Batory stated that lymphoepitheliomas constitute 16 per cent of tumors of the head and neck in children. These tumors are, of course, found more frequently in adults, and the problem of diagnosis is a bit simpler. Fortunately, these lesions are of such structure that they are extremely radiosensitive. Extension of the tumors in the nasopharynx will result in involvement of practically all the cranial nerves.

Whereas the prognosis is always grave in nasopharyngeal lymphoepitheliomas, good results are frequently obtained with early, thorough radiation.

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THE ROLE OF TRANSIENT-INDUCED REVERBERATIONS IN ELECTRO-ACOUSTICAL SPEECH AMPLIFIER SYSTEMS.

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INTRODUCTION.

In general, the improvement in hearing attained by the hard-of-hearing through the use of electro-acoustical amplifying devices falls considerably short of what might be expected¹ on the basis of restored sound level and frequency response. Observation shows this discrepancy to exist, not in the ability of the individual to respond, but in a misunderstanding of the meaning usually assigned to the terms "sound level" and "frequency response"; for if the term "sound level" is specified to refer to the level of amplified, but unmodified and uncontaminated, transient sound impulses such as found in speech and music, this discrepancy is reduced or disappears entirely.

Frequency response as ordinarily given or measured by continuous sine wave excitation has little or no significance in itself.² If one specifies that the output of the amplifier must be unmodified, its transient response must be perfect. This in turn requires a flat or uniform frequency response over a wide range, not only on sinusoidal sound waves, but also on transient pulses; in addition, when an unmodified output is specified, this qualification requires the power output of the amplifier to be sufficient to assure that linear amplification exists without overloading on instantaneous peaks.

Specification of an uncontaminated transient output pulse in turn assures that harmonics are not added by non-linear distortion and that there is no intermodulation distortion. Finally, this specification makes certain that no internal reverberation or "ringing" exists.

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It is the purpose of this article to suggest that these little-known or little-considered transient properties of speech amplifiers are important, and that poor transient response is probably responsible for many of the difficulties encountered by the hard-of-hearing in the use of such equipment.

It is the further purpose of this article to show that it is possible to provide a system having good transient response, and that it can be determined by measurement whether a good or poor transient response exists.

MATERIALS AND METHODS.

In the experimental investigations reported in this article a number of representative miniature audio amplifying systems were tested for frequency response, dynamic range, maximum power output and transient response characteristics. The reference standard, where applicable, was a calibrated miniature condenser microphone system (Altec-Lansing M-11) coupled to a specially constructed ultra-high-fidelity amplifier for faithful reproduction of transients.² Energy spectra were analyzed by means of a General Radio Co. wave analyzer (Type 736-A). Visual oscillographic observation of waveforms was maintained during the analyses.

THEORETICAL CONSIDERATIONS AND FINDINGS.

The difference between distortion and reverberation in amplifiers may be seen in Fig. 1. When a square pulse shown at A, having a time duration of $t_2 - t_1$ and having an amplitude or pulse height h , is altered by passing it through an amplifier system having distortion due only to non-linear amplification and poor frequency response, the approximate shape of the emergent pulse is given at B. Failure of the system to follow rapidly changing amplitude distorts the sharp corners and causes a loss of character.

A system having resonance, or oscillating tendencies, will not be able to follow a sharp rise in amplitude, but is limited to a rate of change compatible with its natural frequency. When excited, the tendency to oscillate may carry the amplitude far beyond the proper maximum, resulting in a series of decaying waves, or a damped wave train, as shown at C.

It may be observed that the amplified pulse shown at *B* always has less peak amplitude than it should have, while the amplified pulse shown at *C* may attain a peak, or transient pulse, several times as great as it should be. The pulse at *B* has lost some of its characteristics. The pulse at *C* has gained an additional characteristic; that is, reverberation or unrelated noise.

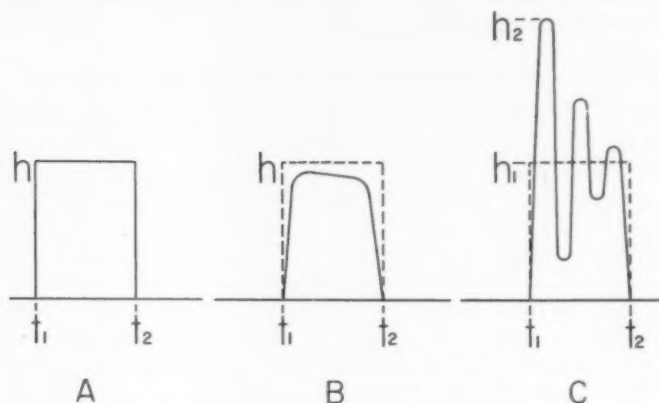


Fig. 1. A, exciting sound pulse having amplitude h , and duration $t_2 - t_1$; B, change in pulse after passing through amplifier having distortion; C, change in pulse after passing through amplifier having definite resonance or internal reverberation.

If the pulse shown at *C* represents the output potential of an amplifier system in volts, and the transient excursion reaches a peak value of h_2 of 3.1 times its average value h_1 , the unrelated peak noise background power in the output at that time becomes 10 times greater than the power representing the original exciting impulse. Peak power values of 50 times have been observed in actual practice.

Reverberation and distortion usually exist simultaneously in a system, each exaggerating the other.

There is always an upper limit of power, or sound pressure, which may be safely applied to the ear canal.³ This limitation is usually, and desirably, achieved by saturation or peak clip-

ping somewhere in the amplifier system. Reduction of reverberation, by lowering the total peak amplitude of sound pressure present, permits the use of a much higher, safe, useful, signal level, with less distortion, and no peak clipping over a wider range of intensities.

Any part of an audio system which has individual resonant properties produces a damped wave train upon excitation, and this process is known to audio engineers as "ringing."² Actually the result is internally generated echo or reverberation, and as it is very difficult to measure and specify satisfactorily, it is not usually done.

In order to show the importance of this completely neglected property of hearing aids, an investigation of several typical hearing aid systems was made with regard to their behavior on pulse or transient excitation. The method consisted of generating in air a free field single pulse, exposing the hearing aid system to it at a sound pressure level well within the power handling capacity of all units tested, and measuring the energy produced in a proper resistance load at different frequencies by means of a General Radio Co. wave analyzer, at different pulse repetition rates. The results cannot be shown well graphically, or stated in simple terms, because different repetition rates of the same non-sinusoidal pulse excite a different series of resonances or internal echoes, and a graph or table of values must be obtained for each repetition rate. A tabulation of the behavior of two typical hearing aids systems under ideal conditions is given for one repetition rate in Table I.

A free field pulse was monitored in an essentially anechoic chamber by an Altec Lansing BR-150 condenser microphone system, and the relative energies in per cent contained in the pulse itself at each of the frequencies in Column I is given in Column II. The energy present in the pulse at the fundamental or pulse rate frequency of 360 cycles per second, was taken as 100 per cent.

As might be expected, maximum energy of the pulse exists at a frequency equal to the repetition rate, and the energy existing at any other frequency is, therefore, less than that existing at the fundamental frequency. The pulse thus an-

alyzed should not change its energy distribution in passing through an amplifier unless the amplifier has poor transient response, and the amount of change incurred in energy distribution at different frequencies in traversing the amplifier system is an indication of the accuracy of the transient response of the system. It must be remembered that this does not evaluate the frequency response of a system *per se*, for only one repetition rate or frequency is introduced.

TABLE I.

I	II	III	IV	V
Frequency	Energy	System 1	System 2	System 3
360	100	100	100	100
720	27	64	256	64
1080	25	81	900	90
1440	8	25	400	36
1800	13	49	900	72
2160	9	49	900	49
2520	13	100	1089	25
2880	8	169	1156	19
3240	9	324	900	12
3600	10	3360	900	9
3960	8	325	400	6
4320	16	441	576	3
4680	10	196	121	6
5040	25	169	240	13
5400	10	121	56	8

Change in energy-frequency distribution of a sharp pulse spectrum as given in Column II occurring when the pulse passes through three different electro-acoustic systems at a repetition rate of 360 pulses per second.

Column I gives the frequencies at which the corresponding percentages of relative energies of Column II are found in the original pulse.

Column III and Column IV show the changes occurring in the spectrum of Column II after the pulse passes through two typical systems.

Column V shows the changes occurring in the spectrum of Column II after the pulse passes through the improved system.

Results obtained in this manner and shown in Table I must be interpreted on the basis of the translation of, and addition to, the energies existing in the original introduced pulse at the various frequencies. It must also be considered that this is not only a redistribution of energy, but also the addition of energy from internally generated sources, for the redistribution spectrum contains proportionally more energy at some

The author expresses his appreciation to Armin Graber, director of the Hearing Institute of the Colorado Springs Medical Center, and William Holmgren of Vicon, Inc., for their generous effort expended in the construction of equipment and the observation of the data given in Table I.

frequencies than existed at the original fundamental rate frequency. Thus the value of 3360 shown in Column III represents 33.6 times the energy which existed at 360 cycles.

Column III shows the redistribution of energy which occurs as the result of reverberation when the pulse having energy distribution shown in Columns I and II is passed through a typical hearing aid system. Column IV was taken in the same manner as Column III except for another typical system.

Column V gives values as obtained in Columns III and IV, but for an experimental system designed to improve transient response and eliminate or reduce internal reverberation or echo. The difference is at once apparent.

Table I shows that a transient non-sinusoidal sound pulse may be so altered in traversing an ordinary hearing aid that its final frequency-energy spectrum is completely unrecognizable.

Unfortunately, one cannot say how bad Systems 1 and 2 of Table I are, or which one is the better of the two. One can see at once that both systems generate large internal unrelated echo, and that in each case the echo becomes several times greater than the pulse which produced it, and that this extra energy represents truly irrelevant sound. The internally generated reverberations of System 1 appear to be concentrated in a fairly narrow band sharply centered at 3600 cycles per second.

System 2, while not exhibiting an extreme reverberant peak at any one frequency, produces many somewhat smaller peaks spread over a large frequency range, apparently producing a total unrelated noise power far in excess of that of System 1. In contrast, System 3 reproduces the energy spectrum of Column II much more faithfully, and would appear to be relatively free of noise power generated by internal reverberant effects. These interpretations of Table I were substantiated by critical listening tests.

Reverberations which are highly damped or of short duration may exist only during the time the original pulse exists and so produce an instantaneous background which disappears when the sound transient ends. These effects are extremely

insidious, for to the listener in an ideal location all is quiet until a sentence is spoken by one individual, at which time it sounds to the listener as though a louder instantaneous background of other noises and sounds exists, which defies detection or location.

Reverberations of longer duration are more like echoes and are, therefore, more obvious and, while perhaps less distracting, add to the general noise-to-signal ratio as an increase in unrelated background. The effect on the listener is to give the impression of a noisy and unnatural background through frequency translation and the disproportionate addition of energy to the usual small but real background sounds.

When strong reverberations exist in a system, saturation or overload and peak clipping occur, not only when the desired sound impulse drives the amplifier to saturation, but also when internally generated background noise amplitude, which is then greater than the desired sound impulse amplitude, saturates the amplifier first. It follows then that greater useful power output may be obtained from a given system if power is not wasted in amplification of internal reverberation.

GENERAL DISCUSSION.

It can be shown by means of a high fidelity audio system that frequency response curves of a system taken without consideration of, or regard to, other dynamic effects have surprisingly little significance when the system is used for the correction of hearing defects. Frequency response curves are generally taken by means of sine wave inputs of different frequencies, and by the very nature of harmonic motion and harmonically varying electrical currents there is a tendency for an entire system, including microphone, amplifier, and earphone, to behave like a pendulum and follow a sustained sine wave input, so that the output waveform on an oscilloscope may look very good indeed.

Most amplifiers measured this way would appear to have a wide and flat frequency response; but if a non-sinusoidal waveform, such as a square wave or single pulse as shown at A, Fig. 1, is introduced, it would be found that the instrument fails to follow sharp changes in incident or transient waveform, and the result would be a waveform as shown at C.

Sounds which exist in nature are seldom continuous, but vary over a large dynamic range and wide frequency spectrum, so that normal speech produces instantaneous sound pressures having extremely sharp and transient character. For this reason accurate transient response becomes the one most necessary single characteristic of electro-acoustical transducers.²

One may easily demonstrate by means of an oscilloscope that any transient sound wave of short duration produces within a poorly designed system a damped wave train, which frequently endures for a length of time much greater than the duration of the single initial exciting impulse. There will usually be one dominant fundamental frequency excited in this manner, and this is the frequency at which the microphone and earphone will acoustically couple to produce a howl if placed close together.

There are also a number of other modes of vibration or resonant frequencies of such a system which are excited whenever the shape of the incident transient waveform is changed.

Each possible resonant frequency which may be excited by a transient sound wave constitutes a separate source of unrelated noise generated within a system. A truly aperiodic system having no excitable resonant frequencies at a given sound power output level would, by its very nature, have a flat frequency response over wide limits; but a flat frequency response, particularly over a limited range, when obtained by means of a continuous sinewave generator, does not indicate that excitable resonances do not exist.

This lack of relationship becomes readily understandable when one considers that these systems consist of three parts: a microphone, an amplifier and an earphone. It has been customary practice to compensate individually one of these three units against the other two and each against the other so that their resultant behavior produces a relatively flat frequency response as measured in terms of continuous sine-wave sound energy. Such compensation may not be, and usually is not, effective in producing faithful response on

anything but sinusoidal waveforms, which is not the object of accurate speech reproduction.

Resonant peaks may exist in a system at a frequency which is above that which can be reproduced by an earphone or above that which may be heard by an individual. Resonance, however, at any frequency produces reverberation, and the resulting internally generated wave trains may mix with the complex waveform of the useful sound being amplified, thus adding noise power at sum and difference frequencies, many of which are in the audible range.

It is unfortunate that one cannot assign a simple number, or factor of merit, to the transient response or fidelity of a system, so that comparison could easily be made on a scientific basis. This cannot be done because the transient response is dependent upon many things and is affected by each in a different way. At first it would appear that when we speak of poor transient response, we mean excessive distortion. Distortion, however, in electro-acoustical systems usually refers to the production of harmonics of the original impulse and is always related to the original impulse. Distortion is but one effect which may enter into transient response, and in general the term distortion should be applied only to the process whereby a sound impulse, in going through the system, is modified and poorly reproduced. One may learn to tolerate and even to discriminate accurately in the presence of severe distortion,³ as one would learn to understand an individual having a severe speech impediment. Distortion is at least related to the waveform which is being distorted.

Failure of transient response due to resonant effects in any part of the system is, however, an entirely different matter. Resonant effects excited by a transient pulse and temporarily sustained as reverberation within the system may become totally unrelated to successive pulses with which they co-exist and, therefore, cannot be learned or be associated in any way with a given type of sound impulse. The effect of such internally generated noise is to increase what might be termed unrelated instantaneous background or, in effect, to produce "masking."⁴ Because of the seminatural tonal quality of such unrelated background as opposed to the continuous hiss-type

background, it becomes impossible to separate it from the natural sounds to which one is trying to listen.

The length of each wave train excited by a transient may be so great that it does not die out between succeeding transient impulses, and as each impulse produces or excites wave trains of different fundamental frequencies, these are added vectorially, and the result is failure in the ability of the listener to discriminate between small useful and large useless components because of this insidious type of confusion. One finds that much of the available power in some systems is wasted in the production of useless and confusing sound.

Internal reverberation increases peak instantaneous power and so reduces the useful dynamic range of any system by causing a small signal to ride upon and be amplified with a much larger useless signal, while at the same time causing distortion of the weak signal by putting it on top of the peak of the internally generated but unrelated noise component, where it is most likely to be distorted by any overdriven part of the system, or clipped, if peak clipping can occur.

There are various reasons why considerable dynamic range is essential. The Fletcher-Munson curves⁵ show that the intensity or level at which a given shape pressure wave is introduced into the ear canal alters the quality of the sound perceived, due to change of sensitivity of the ear to different frequencies at different sound levels. There is, obviously, only one intensity at which a given sound can be heard naturally in any given ear. It also follows that once this correct sound level has been established for one given sound all other sounds will be at the correct or best respective level, unless the electro-acoustic system fails to have linear amplitude response and sufficient dynamic range. Once properly established, there is no theoretical justification for desiring or permitting a change in gain-control-setting unless the device has insufficient range.

The Harvard report shows that when a high fidelity amplification system is provided, a flat frequency response is usually preferred by the hard-of-hearing, the only acceptable modification being a 6 db, or less, per octave rise in high frequency response.^{1,3} One may also expect this result, theo-

retically, from the fact that only an amplifier having a flat frequency response over a very wide range of frequencies could permit perfect transient response, and the only modification of such an amplifier which would not exhibit discrete resonance would be a continuously sloping characteristic.

Almost any simple method of altering frequency response alters transient response to such a degree that the effects obtained may be attributed more to alteration of transient response than to frequency response.

CONCLUSIONS.

Measurement of transient induced resonance, or reverberation, in electro-acoustical systems indicates that good transient response is of primary importance in speech amplifiers used by the hard-of-hearing. Data measured by means of a wave analyzer are given for several typical systems which show the change or translation of the energy-frequency spectrum that occurs when a sharp repetitive transient pulse of known energy distribution traverses these systems.

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The Virginia Society of Ophthalmology and Otolaryngology is sponsoring a convention cruise to Havana and Nassau on May 26 to June 2, 1956. Sailing from and returning to Norfolk, Virginia, the "Queen of Bermuda" will act as the hotel for the trip. Fare for seven days, \$165.00 and up per person. Make reservations with United States Travel Agency, Inc., Washington, D. C.

THERMAL EFFECTS ON THE TYMPANIC MEMBRANE.*

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About eight years ago, shortly after assuming the otological consultation responsibilities for a branch of one of the nation's largest steel producing companies, an elderly man came to me complaining of a discharge from his ear. On taking his history, I found that 20 years previously he had suffered a burn of the tympanic membrane when he was caught in a shower of sparks during the process of pouring an ingot. The patient very curtly and precisely explained his trouble with, "I got a spark in my ear, Doc." I had no idea how frequently I was to hear this expression and how it was to be the stimulation of my interest in a problem which, at the time, I had no idea existed. On further questioning this patient, I learned that after the initial injury, he had been troubled with periodic attacks of mucoid or purulent discharge from this ear.

He would report to the first aid station and receive treatment for a period, finally being sent to the otological consultant for examination and treatment. All this was done on company time, and with hourly wages being paid. Examination of the patient showed a central type perforation in the inferior anterior quadrant of the tympanic membrane. The margin of the perforation was quite smooth and appeared to have a thick, rounded edge. The tympanic membrane in the immediate area about the perforation was dull and opaque. At the time of this examination, I had no idea how frequently I was to have the opportunity of seeing the same picture.

From this experience, I concluded I would have to have more knowledge of such injuries. With a great deal of en-

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thusiasm and the smug feeling that comes with the sure knowledge of past experiences, I turned to a review of the medical literature for an answer. This enthusiasm and smugness soon turned to a feeling of frustration and helplessness. Hours of searching the medical literature proved only that others in the past had not shared my enthusiasm for the problem, or

OCCUPATION AT TIME OF ACCIDENT.

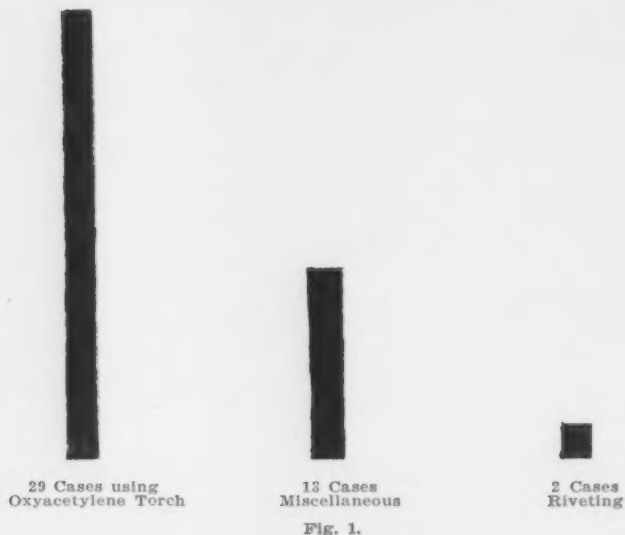


Fig. 1.

had considered it so inconsequential that it did not deserve recording. As time passed, the opportunity to see and observe the progress of spark burns of the tympanic membrane occurred. Some definite clinical information was accumulated. It is the purpose of this report to record these observations and where possible, attempt a theoretical explanation of these clinical findings. There has been no experimental work done, to my knowledge, to prove or disprove these theories.

My first impression was that these burns occurred purely by chance, that as workers in the steel industry went about

producing steel, they were exposed to sparks or bits of flying molten metal in many steps of the production. As experiences accumulated, it became evident that the majority of these burns were occurring among those workers who used the acetylene torch for burning or cutting steel (see Fig. 1). This was especially true when they carried out the operation in a cramped or overhead position.

Historically it is interesting to note that Le Chatelier is credited with having discovered the oxyacetylene flame in 1895, and that the first oxyacetylene torches were made in 1900-1901 by Fouche and Picard of France. Eugene Bouvnonville brought the first welding torch to this country in 1906, and since its introduction there has been a continued and expanding use of the oxyacetylene torch in industry. The oxyacetylene flame produces the highest flame temperature known to man and is the easiest to regulate. In one of the rare mentions in the medical literature on this type of burn, Mosher¹ in 1935 stated: "Unemphasized in the medical industrial literature, but becoming an increasingly important industrial hazard among men who do acetylene welding is the entrance of slag into the mastoid region. Loss of hearing has serious psychological and economic reverberations on the person affected. Partial or complete deafness may be a serious aftermath of burning of the tympanic membrane by slag.

Mosher based his observations on the treatment of 13 patients and pointed out: "the majority of these patients suffered injury to the left ear; the right was affected in left-handed workers. Intense pain, swelling, and redness of the tympanic membrane are the first symptoms. About three days later discharge occurs. It is usually profuse and washed out by it are the tiny foreign bodies responsible for the damage. After 24 hours the discharge may cease, and the ear remain dry; however, the slag may remain buried in the mastoid. Discharge will then continue spasmodically until all of the foreign body has been expelled. Next to prevention in importance, immediate proper treatment is necessary to preserve normal hearing. Treatment consists merely of gentle cleaning of the auditory canal once or twice a week. Any form of applied medication or irrigation of the ear proves irritating and prolongs the ailment." I quote Mosher's report in detail

because it was the basis for the first attempts at treatment; and because my observations, as will be brought out later, differ from his in some respects. Papers discussing the problems of health and protection of workers using oxyacetylene, give little attention to the tympanic membrane.

Cranch and Vosburgh² published a paper in 1942 entitled: "Health Aspects of Welding," in which they state: "The purpose of this paper is to offer some practical points for the better protection of the health of welding operators"; but they do not mention injuries to the ear drum. In 1942 the National Safety Council published a Safe Practice Bulletin³ entitled: "Gas Welding and Flame Cutting," in which detailed instructions are given for the care of equipment and operator, but no mention is made of protection for the ear. In another bulletin⁴ published by the Council entitled: "Protective Clothing," the subject is dismissed with: "for welders and others whose ears may come in contact with molten metal sparks, ear protectors of wire and felt construction are available." Walsh and Britton⁵ mention in their report, "Health Hazards of Electric and Gas Welding," published in 1941: "the occurrence of otitis media following the perforation of the ear drum by molten metal splattered from neighboring welder's work."

Moritz and Henriques^{6,7} have made experimental studies of thermal injuries to the skin, and some of their basic findings may well be reviewed to help in explaining some of these clinical observations in burns of the tympanic membrane. These investigators reported: "the time required to produce irreversible injury bore an inverse relationship to temperature. The higher the surface temperature, the steeper the trans-cutaneous gradient becomes and the shorter the time required to destroy the epidermis. As surface temperature is increased, the damage to the deeper tissue becomes relatively less severe than to the superficial cells."

They also reported that: "the surface color of third-degree burns ranged from pale gray through red, purple and brown to black, depending on certain attributes of the exposure responsible for their production. A red, purple, or brown surface, due to the presence of blood in the superficial layers of

the skin resulted from exposures in which the dermal temperature was raised slowly enough to permit advanced engorgement of the superficial capillary plexus before the occurrence of coagulation. A gray or ischemic surface indicated that the upper portion of the dermis had undergone thermal coagulation before the superficial capillaries had become fully

CERUMEN.



Absent in 29 Cases



Present in 7 Cases

Eight cases in study not included because the time interval between accident and time of examination was too great.

Fig. 2.

engorged." They also conclude that: "although the quantitative results of a short exposure of high intensity may be similar to those of a long exposure at low intensity, they are likely to be significant qualitative differences between such injuries. Hyperthermia of high intensity results in a coagulative type of necrosis in which the dead tissue does not undergo autolysis, resist organization and is usually disposed of by sequestration. Hyperthermia of low intensity results in noncoagulative type of necrosis in which the dead tissue undergoes

autolysis and is readily susceptible to organization." It is from these findings that I have attempted to explain the clinical observations made in a series of cases where the tympanic membrane was the recipient of thermal injury.

Clinical observations that have been borne out by a series of 44 cases:

1. Burns of the tympanic membrane were not observed in cases in which cerumen was present in the external auditory canal (see Fig. 2).

2. Perforations do not always occur immediately, but may be delayed for 48 to 72 hours.

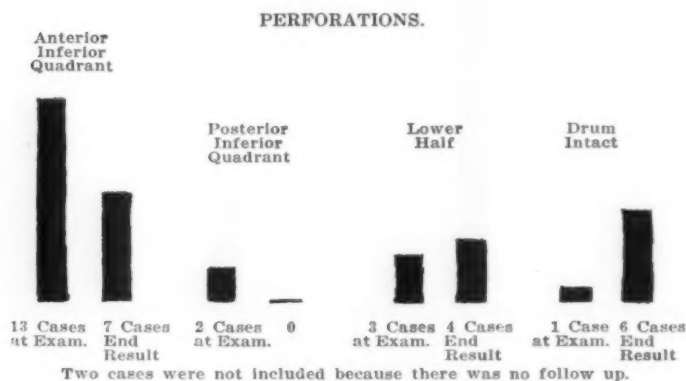


Fig. 3.

3. Discharge following a burn, with or without perforation of the drum, may be delayed 48 to 72 hours.

4. Prognostication as to the delayed appearance of a perforation of the tympanic membrane can be made by the appearance of the drum.

5. A majority of the perforations occur in the inferior anterior quadrant of the tympanic membrane, and are of the central type (see Fig. 3).

6. The edge of the perforation resulting from a burn heals rapidly and assumes a smooth rounded appearance.

7. Perforations larger than one-eighth (estimated) of the area of the quadrant of the tympanic membrane in which it occurs will not close over. Generally perforations resulting from burns are resistant to attempts at encouraging closure.

8. The use of antibiotics and a local agent capable of assisting in removal of debris, shortens the time of disability and preserves hearing.

OCCURRENCE OF OTITIS MEDIA.

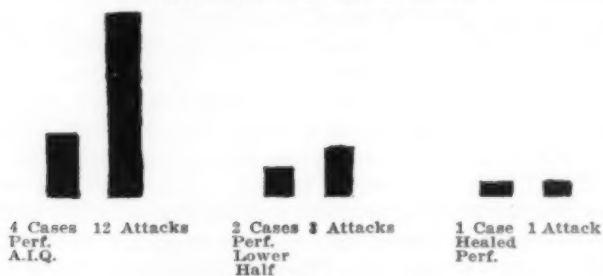


Fig. 4.

9. The occurrence of repeated attacks of catarrhal or purulent otitis media is common following a burn of the tympanic membrane resulting in a perforation.

CERUMEN.

There have been no burns of the tympanic membrane noted in those cases in which cerumen could be demonstrated in the external auditory canal. Frequently, I have examined workmen who report to me because they have had a spark fly in the ear and are concerned that some damage may have occurred to their drum. In none of these cases have I been able to demonstrate any evidence of damage to the tympanic membrane. Cerumen could be demonstrated in all cases. These men frequently report they heard a sizzling or frying noise in the ear when the spark entered. This occurrence is appar-

ently not too uncommon, for on questioning a number of workers using the oxyacetylene torch, they related similar experiences. On examination, it was found they had fairly large cerumen deposits in the external auditory canal. Apparently the spark is slowed down or stopped when it reaches the cerumen; and the workman's reflex action of shaking his head on feeling the spark enter the ear, allows it to be ejected immediately without damage to the tympanic membrane.

DELAYED PERFORATION.

Following the entrance of a spark in the ear, examination frequently reveals no evidence of a perforation of the drum in the ensuing 48 to 72 hours. Examination after this interval will reveal a well-rounded perforation, with the characteristic thick, rounded edge. This may be explained on the basis of Moritz and Henriques^{6,7} findings that hyperthermia of high intensity results in a coagulation type of necrosis which resists organization and is usually disposed of by sequestration. Sparks may be thought of as miniature fires, consuming the burning material at a terrific speed and having that consumption accelerated by oxygen in the air as they speedily pass through it. Their temperature,^{8,9} could well range from 1000° to 1500° C. Thus the source of hyperthermia of high intensity would be present for a very short interval. This impact with the drum is thought to cause immediate coagulation of the blood vessels and results in a necrotic area in the drum, which separates in two to four days, and leaves a round, smooth-edged perforation. I have never observed any granulation tissue on the edges of these perforations.

AURAL DISCHARGE.

Discharge from the ear may be delayed from 48 to 72 hours following the entrance of a spark in the ear. This is true with or without a perforation being present. This discharge, in the early stages, appears to be of a serous type, and is believed to be due to vascular permeability. Moritz and Henriques^{6,7} found that: "thermal vasodilation characteristically leads to increased vascular permeability and edema forma-

tion. The escape of edema fluid at any particular sublevel requires: 1. That the vascular injury at that level has been sufficiently severe to result in increased mural permeability; and 2. That it has not resulted in cessation of blood flow through the damaged vessels." It is believed that such changes occur in the tympanic membrane and result in the eventual escape of serum. If antibiotics are not used, this fluid becomes purulent.

PROGNOSTICATION OF PERFORATION OF THE DRUM.

If the opportunity presents itself for seeing a drum in the first 24 hours following a thermal injury, one can frequently predict the occurrence of a perforation by the appearance of the drum. If the drum has a uniform pink to reddish appearance, it is not likely that a perforation will occur. If the drum has a dull yellowish gray appearance, with all evidence of luster lost, one can expect a large perforation in the following 24 to 48 hours. In drums where there is the appearance of radiating vessels being congested and seemingly extending from an area brick red to yellowish gray in color (no matter how small the area) a perforation can be expected in that area in the following 24 to 48 hours. When the drum appears uniformly pink to red, I feel this is analogous to the erythema seen in the skin with a first-degree burn. Frequently, in such instances, a "blushing" is noted in the osseous portion of the external auditory canal.

It is believed that the spark is in its last moment of consumption as it enters the canal, and the heat engendered by its burning is present only for a moment before consumption is complete and the source of heat is gone. This type of burn will show recovery in 48 to 72 hours, with the tympanic membrane assuming a normal appearance. The grayish drum is characteristic of the early stages of necrosis. This necrosis is caused when the drum is subjected to intense heat for a short interval, causing coagulation before vasodilatation can occur. Perforation occurs in the ensuing 48 to 72 hours, and usually results in a large central type perforation, occupying part of two or more quadrants of the drum. There is apparently a sequestration of the damaged area, and the surround-

ing tissue goes on to eventually assume a normal appearance. The perforation then remains static.

In the drums where radiating engorged vessels are observed extending from an area brick red to yellowish gray in color, one frequently observes a perforation at this focal point in 24 to 72 hours. It is believed that such a burn is caused by a very minute spark contacting the drum at this point. Coagulation occurs at the point of contact, and then the intense heat is dissipated radially from this point and into the air contained in the middle ear. One will occasionally observe these perforations becoming slightly larger in the ensuing 48 hours after their appearance, and then remaining stationary in size.

PERFORATION IN THE ANTERIOR INFERIOR QUADRANT.

Frequently these perforations occur in the inferior anterior quadrant of the drum, and are always of the central type. Heermann¹⁰ also made this observation. No marginal perforations have been observed. There is no explanation for the frequent occurrence of the perforation in the inferior anterior quadrant, except that the workman's head is tilted upward in such a position as to make a straight line from the point of entrance of the spark to the inferior anterior quadrant of the drum. The central type perforation is explained on the basis of the blood supply of the tympanic membrane, although Heermann¹⁰ explains it on the basis of the Leidenfrost phenomena. The blood supply enters partly along the long process of the malleus, and partly from the margin of the membrane. Because of the better blood supply around the periphery of the drum as compared to the center portion, there is greater opportunity to maintain vascularization and thus prevent necrosis in this area.

EDGE OF PERFORATION.

The edges of the perforation, resulting from a burn, apparently heal very rapidly and quickly assume a rounded edge. This is assumed to occur because of the coagulation and necrosis. The blood vessels are destroyed in a given area and

the ends sealed off. Fibrous tissue quickly covers the edge and leaves a smooth, rounded surface.

CLOSURE OF PERFORATIONS.

Perforations resulting from burns are resistant to attempts at closure. It has been my experience that perforations larger than one-eighth (estimated) of the quadrant involved, will not close spontaneously. Perforations smaller than one-eighth of the area frequently close spontaneously; but if they are present for five to six days without evidence of closing, they remain open. Attempts at closing the perforations, using trichloroacetic acid, have failed. I feel that these perforations are difficult to close because we are dealing with a tissue that has a damaged and minimized blood supply. The use of acid is believed to add further insult to an already damaged tissue.

TREATMENT.

Treatment has been found to be most effective if antibiotics are given systemically early and to full therapeutic dosage. When discharge occurs, the use of a local agent such as glycerite of hydrogen peroxide assists in removal of debris. In early cases, Mosher's¹ suggestion of: "gentle cleansing of the auditory canal once or twice a week" was carried out. Under this regime, infection frequently occurred, and the time of discharge was prolonged and hearing was lost. The use of antibiotics locally was tried and the results, although better, were not satisfactory. It was not until antibiotics were given systemically and a cleansing agent used locally, that satisfactory results were obtained. The use of penicillin, 400,000 units intramuscularly daily for five to seven days, is now being used. The antibiotic is given intramuscularly so as to be assured the patient gets the medication.

Oral medication was tried and proved satisfactory when the workman took it as prescribed; but a goodly number would fail to follow orders, so the intramuscular route is now used to insure proper continuity of medication. Glycerite of hydrogen peroxide, 10 to 15 drops, is instilled in the affected ear twice daily. It is left in place five to ten minutes, following which the head is turned and the medication allowed to

drain out for three to five minutes. Examination is repeated at five to seven-day intervals, in order to allow for observation and adjustments in treatment.

During the treatment of the first cases, when the discharge was persistent, I felt I was dealing with a foreign body in the middle ear or mastoid. X-ray studies were made, but I was never able to demonstrate any foreign bodies by this method. In my experience I have had comparatively few cases in which a foreign body was present and removed. In these cases, the foreign material was either in the external auditory canal or adherent to the drum.

REPEATED ATTACKS OF OTITIS MEDIA.

Because the perforation so frequently occurs in the lower anterior quadrant of the drum, occurrence of catarrhal or purulent otitis media is relatively frequent following such burns. It is also observed frequently in perforations occurring elsewhere in the drum. There is usually a history of upper respiratory infection, or of getting water in the affected ear. I theorize that the mucous membrane of the tympanic cavity is frequently altered by thermal injury, and becomes more susceptible to infection. These patients present the classical picture of catarrhal or suppurative otitis media, and are treated in the same manner.

PREVENTION.

This sequence of events caused by the flying spark: pain, discharge, loss of time from work, permanent damage to the ear drum, frequently decreased hearing acuity, could in the writer's mind, be avoided by the simple expedient of covering the ears with a fine-mesh wire guard, fashioned after the old-fashioned tea strainer and held in place like ear muffs. When such a device is suggested to workmen, they scoff at the idea and complain that such an apparatus would be cumbersome and interfere with their work. Certainly an educational program would be necessary to train them to wear such a protective device, thereby saving themselves from damage to their ears.

CONCLUSION.

Spark burn of the tympanic membrane is a problem with many facets of interest. The psychological effects on the patient vary from the realm of pure imagination to persistent worrisome tinnitus. Patients frequently blame the damaged drum for all their future aches and pains, and come to expect their employer to assume the obligation for their medical care. This feeling tends to become more marked after the patient has had one or two episodes of purulent discharge from the ear. Others are emotionally upset and fear that they will become totally deaf.

The employer's side of the problem deals with the costs of treatment, the loss of man hours, and the future obligation to provide medical care if and when an otitis media occurs. Both the employer and the employee could be saved this trouble, physical and financial, by the use of some simple means of prevention. One wonders if the physical and chemical properties of cerumen hold the answer to a simple protector in the form of a synthetic cerumen that could be applied in the ear canal. A means of closing the perforation would be a big adjunct in minimizing much of the psychological and financial part of the problem. Certainly here is a problem that might be answered by the results observed in animal experimentation with theories displaced with facts.

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MIDWINTER SEMINAR IN OPHTHALMOLOGY AND OTOLARYNGOLOGY.

The Tenth Annual University of Florida Midwinter Seminar in Ophthalmology and Otolaryngology will be held at the Sans Souci Hotel, Miami Beach, the week of January 16, 1956. The lectures on Ophthalmology will be presented on January 16, 17 and 18, and those on Otolaryngology, January 19, 20 and 21. A midweek feature will be the Midwinter Convention of the Florida Society of Ophthalmology and Otolaryngology on Wednesday afternoon, January 18, to which all registrants are invited. The registrants and their wives may also attend the informal banquet at 8 p. m. Wednesday. The schedule has been changed to provide a maximum time for recreation each afternoon.

The Seminar lecturers on Ophthalmology this year are: Drs. Francis H. Adler, Philadelphia; A. Gerard DeVoe, New York; Michael J. Hogan, San Francisco; C. Wilbur Rucker, Rochester, Minn.; and A. D. Ruedmann, Detroit, Mich. Those lecturing on Otolaryngology are: Drs. Frederick A. Figi, Rochester, Minn., Lewis F. Morrison, San Francisco; Charles E. Kinney, Cleveland; John R. Lindsay, Chicago; and Bernard J. McMahon, St. Louis.

LARYNGOCELE AND LARYNGOPYOCELE.

JAMES CHESSEN, M.D.,

and

PATRICK LUTER, MD.,

Denver, Colo.

From the first description by Larrey, surgeon to Napoleon's army in 1829, until this report, world literature has contained only 70 to 80 cases of laryngocele, and only two cases of laryngopyocele. H. Marshall Taylor in 1944 presented an excellent survey of the cases previously reported in American literature. Realizing that our total knowledge concerning such an infrequent lesion can only be increased by individual reports, we submit in addition to a brief resume of the literature, a detailed case report.

Of the many papers reviewed in covering American literature on laryngocele, most report the condition to be "rare"; however, since this condition is omitted from the differential diagnosis of tumors of the neck in surgical texts and papers in the general surgical literature, one is prone to feel that this condition is being overlooked, not only by those interested in laryngology but by the general surgeon as well.

In his monograph published in 1922, Moore gave a detailed anatomical description of the laryngeal ventricle and the sacculus; discussed the comparative anatomy of the ventricle and sacculus, and classified the diseases of the sacculus ventriculae. In brief, he points out that the laryngocele develops from the sacculus, an appendiceal structure protruding from the ventricle of the larynx. This upward projection from the roof of the ventricle lies between the ventricular band of the larynx and the thyroid cartilage.

The saccule is an atavistic structure which shows more highly developed features in monkeys and other anthropods.

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Thus, the larynx contains a predisposing sac for the development of a laryngocele reminiscent of the sac of the processus vaginalis testis, which serves as the precursor of inguinal hernias. A weakness of the thyroid membrane at the point where it is penetrated by the superior laryngeal nerve and the vessels has been accorded a role in the etiology of laryngocele. Since the description of the pathology in this entity by Virchow, all writers agree that the protrusion from the sacculus passes between the perichondrium lining the medial aspect of the thyroid cartilage and the ventricular band. Enlargement, then, proceeds to the upper border of the thyroid cartilage where the cyst may then herniate through thyrohyoid membrane and pass into the superficial structures.

Conditions giving rise to an increased intraglottic pressure are sometimes implicated as being of secondary etiologic significance. Numerous authors mention chronic abuse of the voice, singing, whooping cough, hornblowing, straining at stool, glass blowing, and weight-lifting as contributing factors to the development of herniation of the sacculus.

We feel, as McLauren does, that these common everyday factors are a poor explanation for the development of such a rare condition. Larrey first described laryngoceles seen in Egyptian priests who performed daily chanting of the Koran from the mosques in Cairo. The association of other secondary pathology in the larynx is very important. Schall reports a case in which he found laryngocele associated with carcinoma of the larynx. Leborgne, a radiologist, quotes the incidence of association of laryngocele and cancer of the larynx as being as high as 10 to 15 percent.

From this anatomical explanation of the origin and progressive growth of laryngocele, the following classification is derived:

1. Internal—a cystic dilatation of the ventricle in which the sac of mucous membrane lies completely within the larynx. This entity is characterized by symptoms of hoarseness, respiratory obstruction, and dyspnea.
2. External—characterized by protrusion of the cyst from the sacculus of the ventricle through the thyrohyoid membrane

to the superior cornu of the thyroid cartilage. This type presents as a mass in the neck, often enlarging on coughing, and sometimes capable of being emptied by external pressure over the cyst.

3. Mixed—combines the above types to present a cyst protruding into the larynx as well as an external extension into the neck.

Case Report—The patient, a 54-year-old white male, was admitted to St. Joseph's Hospital, Denver, in May of 1955. He had a previous history of coronary occlusion. He complained of a lump in the left cervical region which had been present for three years, progressive hoarseness, and marked dyspnea. There was no induration, tenderness, or pain associated with the mass, which was located just below the angle of the left mandible. The protruding mass had a cystic feel on palpation. The patient reported that he had noted no variation in the size of the mass from day-to-day, and it could not be emptied by external pressure. He had had no drainage or eruption of purulent or foul material into his pharynx at any time.

Indirect laryngoscopy revealed marked compromise of the glottis by an edematous mass which bulged inward, obscuring the entire left cord and the anterior two-thirds of the right vocal cord. Roentgenograms showed a 6 cm. fluid, air-filled mass to the left of the thyroid cartilage. The mass pressed against the hypopharynx on views taken after a barium swallow.

An emergency tracheotomy was then performed to provide the patient with an adequate airway. It was elected to aspirate the cyst in order to ascertain the character of its contents, but when pierced by a needle it suddenly collapsed. Purulent material was noted at the tip of the aspirating needle when it was withdrawn. The collapse of the cystic mass alleviated the patient's symptoms. His tracheotomy was decannulated, and he returned home asymptomatic except for mild residual hoarseness and pain.

Three weeks later he was admitted to Presbyterian Hospital with a recurrence of his previous symptoms. Dyspnea was marked, and a second tracheotomy was done on the third hospital day. Indirect laryngoscopy again demonstrated marked blockage of the glottic opening by a mass bulging inward from the left ventricular band. Its greatest convexity projected beyond the median line of the glottis, completely obscuring the left cord and all but the posterior third of the right cord.

Anterior, posterior, and lateral views of the cervical region showed a light tumor 6 to 7 cm. in diameter, located in the left side of the neck at the level of the hyoid bone. The lesion contained air and showed a distinct fluid level. Films of the upper esophagus with barium administered by mouth showed evidence of an extrinsic pressure defect in the hypopharynx, but failed to reveal any communication between the esophagus and the cystic mass. No planography was done on this case, although it has been reported as an excellent means for visualizing the form and relationship of an laryngocele.

The day following the second tracheotomy, the patient was taken to surgery. Under general endotracheal anesthesia an 8 cm. transverse incision was made over the mass. The platysma and deep fascia were incised exposing a 6 cm. cystic mass which lay beneath the thinned-out strap muscles, posterior to the omohyoid, and anterior to the sterno-

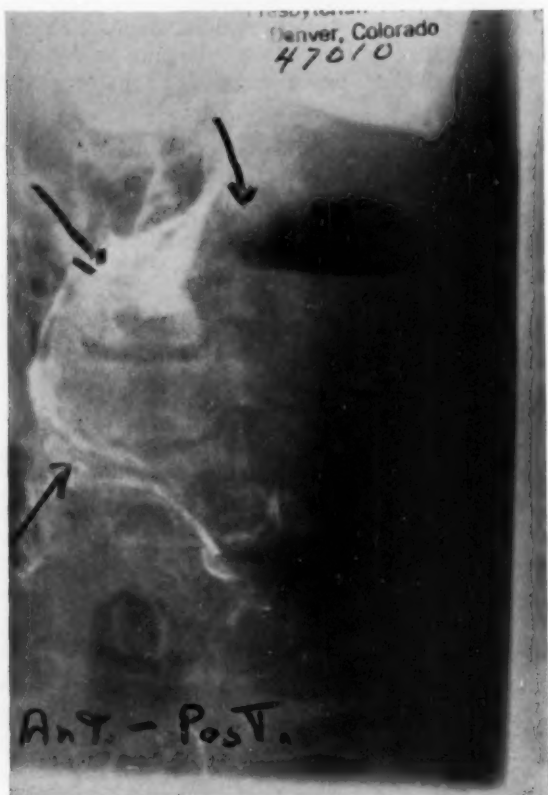


Fig. 1. X-ray Examination: 7 cm. diameter soft tissue mass with air-fluid level left cervical area above level of vocal cords, causing moderate posterior and right lateral pressure defect and deviation on hypopharynx. Incidental finding—Degenerative narrowing 4th, 5th, and 6th cervical interspaces with osteoarthritic lipping at these narrowed interspaces posteriorly.

cleidomastoid muscle. The pedicle of this cyst passed by a narrow stalk through the thyrohyoid membrane and downward along the inner aspect of the thyroid cartilage, to enter the ventricle of the larynx by a three by six mm. opening. The stalk was excised and the stump closed by a purse-string suture of chromic catgut reinforced by two interrupted catgut sutures. The posterior wall of the cyst was tightly adherent to the pharynx by inflammatory reaction.

In following a plane of dissection between the cyst wall and the pharynx, the cyst was inadvertently opened, spilling 40 to 60 cc. of purulent material into the operative field. Simultaneously, the pharynx was accidentally

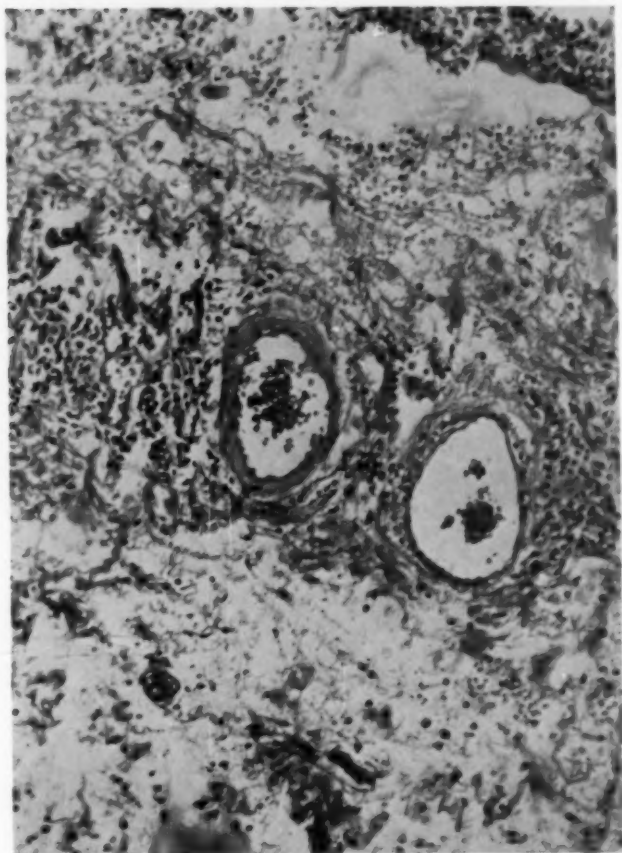


Fig. 2. Macroscopic and microscopic description in text.

opened and promptly closed with interrupted chromic catgut sutures. Cervical fascia was also approximated over the pharyngeal closure for added reinforcement. The deep cervical spaces were then drained with three Penrose tissue drains and the neck closed in layers with interrupted sutures. A culture of the cyst contents failed to show any growth after three days.

The patient's postoperative course was uneventful, with no evidence of deep cervical space infection. The patient received parenteral tetracycline and penicillin for six days following his surgery. Feedings were

administered by means of a small polyethylene tube for three days; then the patient was increased from fluids by mouth to a soft diet in progressive stages.

On the ninth postoperative day indirect laryngoscopy showed some residual edema of the left false cord, but otherwise the larynx was normal, presenting an excellent airway. The tracheotomy was removed following the examination of the larynx, and the patient was discharged on the eleventh postoperative day. It was noted at this time that the patient's voice was a little coarse, but otherwise normal.

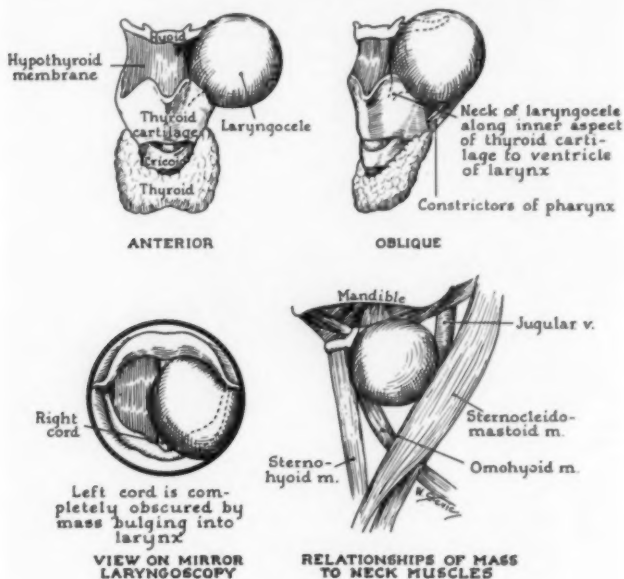


FIG. 3.

The pathological report, made by Dr. Alexis Lubchenko follows:

"Macroscopic—this is a sac-like structure presenting an opening 2.5 cm. in diameter and is 4 to 5 cm. long presenting an apparent perforation on the fundus. The wall of this cystic structure averages 5 mm. in thickness. The lining is somewhat trabeculated, including in some areas velvety mucosa-type structures. The greater portion appears to be ulcerated.

"Microscopic—sections reveal a relatively thick wall of loose fatty fibro-connective tissue heavily infiltrated with granulocytes and round cells, including in some areas prominent microabscesses. Epithelium of the cyst is largely denuded; however, there are patchy areas in which ciliated columnar epithelium can be demonstrated. Cancerous change is



Fig. 4.

not demonstrated in any of our sections, nor is there evidence of specific type of inflammatory reaction. In some portions of the cyst skeletal muscle fibers can be demonstrated.

"Diagnosis—laryngocoele showing extensive subacute, suppurative inflammatory reaction."

We feel that this case, under the classification described, represents a mixed type laryngopyocoele. Secondary infection of the cyst produced granulation, damming back secretions in

the sac in a valve-like manner at the point of exit from the ventricle. This mechanism of formation of pyocele has been described by Freedman. In some cases when pyocele develops, the patient, on coughing, may expectorate pus, although this was not seen in our case. Jackson and Jackson in their text state that they have seen only two cases of external laryngocele, but no cases of laryngopyocele.

Summary: A case of laryngopyocele is reported and the pertinent literature briefly discussed.

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VENTRILLOQUISM—AN AREA FOR RESEARCH.

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Ventriloquism, a unique phonatory and articulatory phenomenon, should be of particular interest to specialists who concern themselves with the vocal and perceptive mechanisms. It is the purpose of this article to comment on some information pertaining to this subject with the hope of stimulating definitive research. Experimentation in this area has been almost exclusively European.

Huizinga¹ claims that an early record concerning ventriloquism dates back to 2000 B.C. Luchsinger² mentions a Biblical reference to ventriloquism. Tarneaud³ points out that ventriloquists often played the role of "comedians" or court jesters during the Middle Ages.

In the way of research, Huizinga² cites an investigation by a Frenchman, the Abbé de la Chapelle. This study, in 1772, was among the first serious attempts to examine this phenomenon. Merkel⁵ discusses briefly the articulatory and breathing movements occurring during ventriloquism.

Flateau and Gutzmann, 1894, cited by Huizinga², published a monograph after systematically observing six ventriloquist subjects. The authors examined the physiological hypotheses proposed by the subjects in the form of introspections.

Thirty-one years later Panconcelli-Calzia⁷ published the results of his investigations using a professional ventriloquist. He made X-ray observations of the vocal mechanism phonating vowels, and also recorded the respiratory movements by kymograph using the Gurtel pneumograph.

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ORIGIN OF PHONATION.

One of the earliest hypotheses concerning the manner of vocal production was that the ventriloquist spoke on inhalation. Another theory was that the ventriloquist's voice came from the stomach. Among the later studies there is unanimity of agreement that the phonation is laryngeal in origin.

THE BREATHING MECHANISM.

Huizinga offers a tentative explanation for the misconceptions centered around the origin of phonation. He points to the observation that the ventriloquist uses a powerful inspiration of air with the diaphragm depressed and in a low "fixed" position. The abdomen is distended forcibly during the entire phonatory period. The thorax is also expanded and sinks only slightly during phonation. Between extended phonations the thorax is re-expanded to allow new intakes of air.

The ventriloquist is supposed to speak almost continually from one maximum inspiratory position of the thorax. X-ray examination showed that the air came from the trachea and not from the stomach or esophagus, as in esophageal speech. Luchsinger and Tarneaud are in agreement that following the large inspiratory effort, the air is expelled in a particularly "slow" manner.

This view is explained by Panconcelli-Calzia, Merkel and Luchsinger, who theorize that following the maximum inspiratory effort, a steady contraction of the muscles of the thorax and abdomen is maintained. This steady contraction is supposed to permit greater force on the vocal folds.

There is a decreased amplitude in the excursions of the thorax and abdomen during ventriloquistic phonation, as shown by pneumographic recordings. A slight swelling in the circumference of the neck is also noted. The sub-glottal air is compressed by a constriction produced by the strong contraction of the entrance to the larynx. The information on these points is rather vague and incomplete.

VARIATION IN THE VOCAL MECHANISM.

Several functional variations in the breathing mechanism have already been cited. The authors agree generally that there is a constriction of the air passage in the laryngeal, pharyngeal or buccal regions. This constriction is mentioned as somewhat analogous to that in deglutition or in vomiting.

The lip movements are greatly diminished and a small, fairly constant mouth opening is maintained. The position of the lower mandible is held fairly rigid. The ventriloquist often speaks out of the corner of his mouth. The tongue is said to occupy a middle position and is displaced laterally only slightly. The naso-pharyngeal opening is found mostly enlarged. The tongue pulls backward and exerts pressure on the hyoid.

The pharyngeal cavity is constricted and its volume diminished. The posterior position of the tongue, plus the upward movement of the larynx, further reduces the volume of the pharyngeal cavity.

The epiglottis inclines over the ostium laryngis. The ary-epiglottic folds are contracted. The larynx rises toward the base of the tongue with some posterior movement. The greater cornu of the hyoid approaches the posterior pharyngeal wall. The cartilaginous glottis exhibits a strong closure.

The organs of phonation give the impression of considerable muscular tension. The bucco-pharynx, according to Tarneaud, is used as a "fixed" resonator with a small orifice. Its volume is influenced by the position of the larynx vertically. In a Helmholtz-type resonator it is known that aperture size and volume are causally related and affect its resonant frequency. Mouth opening may thus be compensated for by alterations in the volume of the resonating cavities. Undoubtedly, this is an oversimplification of even one of the dynamics in ventriloquist resonance.

ARTICULATION AND PHONATION.

Luchsinger and Huizinga found that the ventriloquist's voice was higher in pitch (fundamental frequency in cps) than the normal voice. The latter determined the pitch range

of his subject and found it to comprise about an octave. The details of this procedure were not entirely clear.

Tarneaud states that a large percentage of the consonants are formed between the back of the tongue and the palate. Huizinga found a systematic substitute for the labial sounds. The "m" is replaced by "n", "p" by "th" and "b" by "d". Diplomat might therefore be pronounced as *dithlonat*. These substitutions are supposed to escape the listener who is concentrating on the "tricks" of the ventriloquist. Fleteau and Gutzmann described one of their subjects as being able to produce the labial sounds by applying his lips against his upper teeth.

Sir Paget⁵ describes the articulation of "p", "b", "m", "f" and "v" during ventriloquism. The lips are immovable and slightly apart. The teeth are separated so that the tip of the tongue can be inserted between them so as to close the space.

The performer produces the bilabial sounds by protruding or withdrawing his tongue tip between and behind the inner surfaces of the lips. The "f" and "v" are produced by a partial closure of the space between the lips. The tongue is pressed against the inside of the lower lip just clear of the upper lip.

In general, the vowels are considered to be phonated distinctly although not phonetically pure. Huizinga made a comparative physiological study of the vowels phonated normally and then in ventriloquist's voice. He compared the vocal structures by means of lateral X-ray photographs. The differences attributed to ventriloquism centered largely around the reduced pharyngeal area.

VOICE QUALITY.

Numerous adjectives have been used to describe the quality of the ventriloquist's voice. These labels have little or no validity. Due to the extreme muscular tension of the vocal organs, the voice has been labeled by Tarneaud as an "excessively strong pressed voice."

Due to the reduced volumes of the air passages, the quality has been described as "compressed" "dampened" and well

"focused" or "thin" by Luchsinger. The author found no studies dealing with the psychophysical aspects of ventriloquist voice quality.

The expert ventriloquist is described as being able to produce a great variety of "alterations" of his voice aside from ventriloquism. Panconcelli-Calzia has termed these productions "polyphonic," and suggests that they be studied separately.

SOUND LOCALIZATION.

The ventriloquist is described as using various techniques to deceive the listener as to the location of the speaker. He may employ changes in voice quality, pitch and intensity or a combination of these. He may gesture or employ the movements of a puppet. Perceptible movements of the lips, larynx and breathing mechanism are held to a minimum in order to keep attention away from the speaker. Acting ability and dialogue contribute to the deception that someone other than the performer is speaking.

RESEARCH APPLICATIONS.

The present data suggest that the ventriloquist voice may be accomplished in a variety of ways. The performer uses variations of his breathing mechanism, different pitch levels, voice quality modifications, dialogue and acting ability. In order to define each type of ventriloquist voice, comparisons may be made with normal phonation. Thus each ventriloquist would be a control and experimental subject.

Objective, acoustic analyses of speech and voice variables are possible in the laboratory using phoneloscopic or oscillographic oscillograms, sound spectrograms, sound pressure level recorders and other electroacoustic instruments. Correlative, objective, physiological measurements, using X-ray cinematography of the speech mechanism would be helpful. Judgments of the physiologically and acoustically defined variables could then be made using trained listeners.

CONCLUDING REMARKS.

The results stated in this article are at best tentative. The

evidence is vague and incomplete. The application of modern research tools should be applied to point up the quantitative differences in voice and articulation between normal phonation and ventriloquism.

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TRANSACTIONS
OF THE
AMERICAN LARYNGOLOGICAL ASSOCIATION
(Scientific Sessions)*

SEVENTY-SIXTH ANNUAL MEETING

MARCH 13-14, 1955

HOLLYWOOD BEACH, FLORIDA

DR. HENRY B. ORTON, President

*Abstracted by SAMUEL SALINGER, M. D., Palm Springs, California.

(Continued from October Issue.)



GENERAL TONSILLECTOMY: SUGGESTIONS FOR
MANAGEMENT AND PERITONSILLAR INJECTIONS.

PAUL M. MOORE, M.D.

Moore reviewed the subject of tonsillectomy under general anesthesia, laying emphasis on the value of injecting the peritonsillar area with a saline solution containing adrenalin, 6 minims to the ounce, which not only facilitates the dissection but also markedly reduces the bleeding. He described the preoperative management of the child with the object of minimizing psychic shock. Up to the age of 14, atropine is administered in adequate dosage; older individuals are given a barbiturate. Eufocaine for the reduction of postoperative pain has proven hazardous and has been discarded. He has found that the preoperative use of Cortisone or hydrocortisone is of value in the "thymicolymphatic" type of child. Also the intravenous administration of hydrocortisone has been shown to be effective in combating the hypotension of surgical shock. The operation is performed in the head low position, using the Davis gag with attached tongue blade.

DISCUSSION.

Dr. THOMAS C. GALLOWAY cited statistics from the Evanston Hospital showing a decrease in tonsillectomies from 1000 in 1945 to 400 in 1953. This reveals a trend to re-evaluation of the indications. Regarding the relationship of tonsillectomy to the incidence of polio, he feels that despite conflicting theories tending mostly to show a predisposition on the part of the former to the latter, that the theory of a barrier being removed is not compatible with present theories of the pathogenesis of polio. X-ray irradiation is again beginning to gain favor if properly administered by an experienced roentgenologist. Rhodes' recent paper showing the incidence of bacteremia following tonsillectomy is very impressive, particu-

larly since it revealed a lower incidence in cases done by the Sluder or Beck method, the incidence being proportional to the time consumed in the operation.

DR. HARKINS reported a lowered incidence of bleeding during and after surgery, which he attributes to the routine use of vitamins K and C before, during and following the operation; also he believes good results can be obtained from the use of adrenosan 5 mg IM immediately after the operation.

DR. MOORE, in closing, commented on an editorial in the Journal A.M.A., which stated that a tonsillectomy performed at any previous period of time rendered the subject more susceptible to polio. This seems to overlook the simple fact that surgical repair or normal healing, far from removing a normal barrier to infection, offers a natural obstacle. Regarding the use of the vitamins, he is convinced that they are of great value. Certainly children receiving aspirin will show a low prothrombin. As for adrenosan, his experience with it in a few cases of nasal hemorrhage has not been convincing. He has not tried it in the tonsil cases.



CARCINOMA OF MAXILLARY SINUS IN YOUTH.

BERNARD J. McMAHON, M.D.

Because it is very unusual to encounter a carcinoma of the antrum at the age of 20, Dr. McMahon presented such a case with a discussion of the therapy. The first symptoms were numbness of the cheek followed by swelling and some displacement of the bulb. X-rays indicated pathology in the antrum and ethmoids and the sinus was opened on the assumption that a suppurative process was present with involvement of the orbit; however, the histologic examination of tissue removed showed a carcinoma which appeared to be of the radiosensitive type. Surgery was not advised because of the extent of the growth, and the patient was given irradiation therapy. There was considerable improvement locally, but metastases, first in the neck and then more widespread, proved to be beyond the hope of a cure by any means and the patient succumbed in a very short time. Dr. McMahon cited Prof. Ohngren to the effect that the general impression that metastases occur later, is erroneous. The rich network of lymphatics in the mucosa of the antrum communicate freely with the larger trunks in the neck leading to the glands.

DISCUSSION.

DR. ANDREW EGGSTON has noted changes in the classification of tumors based on studies of histogenesis since World War II. The slides shown by Dr. McMahon are most likely squamous cell types. The anaplastic cells take on peculiar behaviors, often undergoing metaplasia. This accounts for differences of opinion as to nomenclature, depending on who sees the slide and what portion of it impresses them. Apparently more malignancies are being observed in younger individuals than formerly. Recently a case in a child aged 5, originally diagnosed as fibrosarcoma of the sphenoid or ethmoid, was later pronounced a neuroblastoma when studied by several pathologists. Despite radiation therapy the child developed metastases and died. Two other cases of neuroblastoma were seen by Dr. Eggston, one in a boy of 12 and the other in a woman of 45. Whether this is a new type of tumor or a reclassification of an old one is not certain; yet the fact remains that they are anaplastic and highly malignant. Another problem that is perplexing is the increased incidence

of so-called papillary sinusitis. These were thought to be akin to recurring papillomata of the larynx, often attributed to a virus; but in some cases after a long time a recurrence will appear with every indication of malignancy.

DR. FREDERICK T. HILL also has recognized increasing frequency of malignancy in the young. He has been impressed by the symptom of numbness of the face, which is highly significant in early diagnosis. He inquired whether Dr. McMahon had found X-ray evidence of involvement of the canine convexity or orbital plate. Frequently stereoscopic views will bring out early changes.

DR. LEROY A. SCHALL agreed that the symptoms of numbness of the cheek is a very important one. Other symptoms which have impressed themselves are unilateral nasal obstruction, recurring hemorrhage, exophthalmos, pain in the teeth and impaired vision. An analysis of 212 cases by the speaker revealed the majority to be carcinomas, yet only two were in children, although rhabdomyosarcomas and other types of sarcoma were also found. Dr. Schall recalled several other cases in which the symptoms mentioned above were helpful in the diagnosis and supported by good X-ray pictures. The essence of the thing is that one should always be cancer conscious and study these cases carefully in their early stages.

DR. C. E. MUNOZ-MACCORMICK (Porto Rico) reported a case in a child of four with pain and swelling of the cheek where the X-rays showed merely a ballooning of the walls of the sinus. Surgical exposure revealed a highly malignant mass which had eroded the bony walls even into the pterygo-maxillary fossa.

DR. PIERCE THEOBALD reported a case in a 48-year-old enlisted man, whose early symptom was nasal obstruction. It was treated as a sinusitis for some time before a mass appeared in the nose which on biopsy revealed an anaplastic malignancy. X-rays showed extensive involvement of the sinuses which was confirmed by surgery. Apparently it was too widespread to be completely removed, and the outcome was inevitable.

DR. MC MAHON, in closing, stated that the X-rays were carefully studied in his cases, and the contour of the canine fossa and orbital plate appeared unchanged.

The symptoms mentioned by Dr. Schall are all very important and he agreed that numbness of the cheek is particularly significant.



FUNCTIONAL DISTURBANCES OF THE UPPER SWALLOWING MECHANISM.

JOHN R. LINDSAY, M.D.

Functional disturbances of the swallowing mechanism may be divided into three groups, those affecting musculature, innervation and psychic control. Among the first named are such conditions as myasthenia gravis, generalized scleroderma, dermatomyositis and systemic conditions such as tuberculosis, thyrotoxicosis and senility. These may be demonstrated in the barium test when the fluid tends to remain in the valleculae after swallowing. Neurologic conditions affecting the swallowing function comprise peripheral neuritis, jugular foramen syndrome, intracranial lesions affecting the nerves and lesions pressing on the bulb. The

cricopharyngeus may retain its function in some cases or may lose some of its efficiency in others. Examination during the Valsalva maneuver will often determine the efficiency of this muscle. Disturbances of psychic origin are of manifold origin and are commonly found in some types of mental illness. Organic disease must be excluded by careful examination before such cases are turned over to the psychiatrist.

DISCUSSION.

DR. CLAUDE C. CODY noted the reference to age as a factor. He believes that deficiency in vitamin B2 is frequently observed in the aged. It has a bearing on the motility of the esophageal musculature through its action on the innervation. This has been noted also in connection with musculature weakness in tuberculosis. He inquired whether Dr. Lindsay had seen any evidence of vitamin B2 deficiency.

DR. WALTER B. HOOVER has seen cases of bilateral recurrent nerve paralysis but has failed to observe involvement of the cricopharyngeus, which he believes is not innervated by the recurrent nerve; also he has observed cases of Xth nerve paralysis in which the pharynx and the vocal cord on one or both sides were paralyzed, and in which the cricopharyngeus was markedly weakened or relaxed. He would like Dr. Lindsay's ideas on the innervation of the cricopharyngeus from the pharyngeal plexus and whether a lesion of the upper portion of the nerve near the jugular foramen or intracranially would involve this muscle. He suggests that in cases where X-rays fail to demonstrate relaxation of the cricopharyngeus one might well esophagoscope the patient to rule out a possible fibrosis or web formation as the cause of the dysphagia.

DR. EDWIN N. BROYLES recalled three cases of more or less mechanical difficulties in swallowing in the region of the cricopharyngeus. One case which had been diagnosed as globus hystericus was due to a web formation and the other two revealed definite fibrosis which rendered passage of the scope very difficult even under general anesthesia.

DR. S. C. MISSAL reported having seen a number of cases of poliomyelitis with marked difficulty in swallowing associated with a change in the voice, yet the laryngeal function was good, and the palate muscles seemed to act normally. He wondered whether this alteration of the voice was not due to inadequate control of the air column by the pharyngeal sphincter.

DR. LINDSAY replied to Dr. Cody's question by stating that the case in which X-rays were shown did not have a vitamin deficiency. The patient had to be tube-fed because of pain due to ulceration in the mouth and pharynx. He probably had a vitamin deficiency which was rapidly overcome by the feeding; yet the difficulty persisted although to a lesser degree. He emphasized the fact that his presentation was concerned mainly with the so-called functional cases rather than the organic. As for the nerve supply of the cricopharyngeus, the matter is not clear; Negus has admitted that he doesn't know. In some cases it is difficult to determine how the cricopharyngeus is affected in cases of unilateral paralysis of the larynx and pharynx. When the barium spills over into the larynx one cannot be certain whether it is due to diminished sensation or inability of the upper laryngeal mechanism to operate efficiently. Usually in the bulbar polio cases the latter explanation is the more plausible.

Some of the organic causes were mentioned in the paper, because they have to be ruled out before one can consider a diagnosis of functional disturbance. These can usually be demonstrated in good X-ray films.

About the voice changes in poliomyelitis, Dr. Lindsay could venture no opinion; however, in the case of scleroderma which he cited the patient did show a weakness of the laryngeal musculature which was bilateral, resulting in inability to close the glottis effectively. There was a definite air loss on talking and the patient was unable to hicough or laugh for the same reason.



THE GLOBUS SYNDROME AS RELATED TO DEMONSTRABLE PATHOLOGY OF THE CERVICAL SPINE.

LEWIS D. MORRISON, M.D.

Cases of globus in the absence of demonstrable pathology in the throat should not be dismissed as purely neurogenic and turned over to the psychiatrist. The psychiatric approach is too frequently abused. A careful history will often determine the mental equipment and attitude of the patient. Morrison has found that osteoarthritis is often overlooked in the X-ray examination and frequently is the real cause of the disorder. The X-ray findings are described by the author with appropriate illustrations. At times such symptoms as a grating sound in the neck on turning the head, tightness of neck muscles and shooting pains may be elicited. Haphazard physical therapy may do harm, but heat and light massage are always helpful. X-ray therapy in small doses over a period of several weeks has proven beneficial; also ACTH, Cortisone, gold therapy and vitamins. In some cases esophagoscopy affords relief, and in a few instances surgery will have to be resorted to.

DISCUSSION.

DR. C. L. JACKSON mentioned having recently had a patient with a condition closely resembling the last case cited by Dr. Morrison. He is convinced that we need to exercise greater care in the examination of X-ray films because all too frequently these alterations in the cervical spine are overlooked.

DR. LOUIS H. CLERF stated that all too frequently we are likely to ascribe a lump in the throat to some functional disorder, which can be very unfair to the patient. On the other hand, a patient may have a lot of changes in the cervical spine and not have a lump in the neck. Certainly every patient with a complaint of a lump should have the benefit of a thorough study of the cervical spine with the help of a competent roentgenologist. Dr. Clerf showed a slide which indicated changes in two locations which undoubtedly were responsible for the trouble; however, since there was no indication for any serious intervention and since the patient was given to understand the situation, she was content to carry on inasmuch as there was no tendency for the process to become aggravated.

DR. P. E. IRELAND asked the essayist about the influence of posture in this condition. He was thinking of high heel shoes and open toes which orthopedic surgeons have long recognized as contributing to spinal curvature. It is also likely that a business executive sitting over a desk for hours at a time may be subject to this condition. Another possible cause is the posture when reading in bed. Mention was made of a collar for support. Dr. Ireland has fashioned one of a heavy felt, which the patient wears at home especially when watching television which, incidentally,

he thinks is bad business. Isn't it likely that the difficulty in swallowing may be due not only to myositis or fibrositis but also to changes in the bone?

DR. THOMAS C. GALLOWAY recalled an article in the French literature several years ago in which the thesis was developed that these cases are associated with a periarthrititis, a process extending to the mucosa and involving the nerves in the upper portion of Auerbach's plexus. He inquired what Dr. Morrison thought the pathology or pathogenesis of the lipping. Is the process limited to the articular end of the bone facets or a process originating in the soft tissues which may involve some of the sympathetic and vagus fibers?

DR. ARTHUR W. PROETZ requested Dr. Morrison to elaborate his conclusions as to what the lump really is, whether an edema, a paresthesia, a myositis or a muscle spasm. At times the sensation of a lump is absent entirely and might be termed functional; yet it is not an imaginary thing. If one could really know the essence of the disturbance in the various structures mentioned that brings about the sensation of a lump, it would be easier to direct the patient and afford him relief.

DR. FREDERICK T. HILL ventured to add one more possible cause of this syndrome, namely, ossification of the stylohyoid membrane.

DR. MORRISON closed the discussion by answering the questions directed to him. Posture certainly is an important factor and the collar is a useful adjunct in therapy. The important thing, however, is to alert the orthopedic men and the neurosurgeon to this condition, so they may take these cases off our hands. Posture such as the typist and the jeweller assume for long periods should be recognized as factors. It should be noted that when fixation has lasted for a long time the pain may subside, which is why these cases grow worse as is the case with osteoarthritis. As for terminology, he objects to the term "globus hystericus" and prefers telling the patients that they have a cricopharyngeus muscle syndrome complex. Replying to Dr. Proetz, Dr. Morrison believes the symptom is due to a spasm of the cricopharyngeus muscle which does not have to be continually present. Swallowing something will often relieve the condition, which is why nothing shows up in fluoroscopy. Warm foods are better than cold for relaxation. The article which Dr. Galloway referred to is fascinating reading; however, he believes the author has gone off the deep end a bit in interpreting the pathology. He was more impressed by an English article in which the author asked pathologists doing necropsies to investigate the tissues in this area, since grossly very little evidence of the true pathology has been available. The question is whether the pathology is in the bone itself, the ligaments or the adjacent spaces into which calcium deposits may be laid down. He has requested surgeons doing a disk operation or a fusion of the spine to obtain enough tissue for histologic study. This, plus good pre- and postoperative X-ray studies might go far in supplying the answers.

THE CLINICAL SIGNIFICANCE OF A MOTOR PATTERN IN NUCLEUS AMBIGUUS.

A. C. FURSTENBERG, M.D.

Experiments on monkeys by two different procedures have yielded considerable information on the distribution of the cells in the nucleus ambiguus controlling the action of the various muscles of the larynx.

This knowledge may prove of great value in analyzing the complex manifestations of laryngeal dysfunction which at times has been more or less baffling. The fact that the cells of origin for the cricothyroids, the abductor and adductor muscles have been identified, could explain such phenomena as the loss of function of the true cords while the false cords maintain the function of closing and opening. It is, therefore, more than likely that isolated lesions centrally located are capable of producing bizarre combinations of laryngeal dysfunction where the activity of limited groups is affected. It may be assumed that since the pattern of localization has been demonstrated in the monkey it is logical to deduce that the motor pattern in the human being is more highly developed.

DISCUSSION.

DR. LEWIS F. MORRISON could not agree with the statement that a single muscle or portion of a muscle is incapable of being injured or affected by surgery. The fact that the recurrent laryngeal nerve divides in the extralaryngeal spaces into as many as six branches makes it possible for only one branch to be damaged, thus affecting only the muscle which it supplies.

DR. JAMES M. ROBB commented on the accuracy and brevity of the presentation and suggested another field for investigation, namely, the innervation of the cricopharyngeus muscle.

DR. FURSTENBERG agreed, in reply to Dr. Morrison, that it is possible to affect a single muscle through one of the extralaryngeal fibers of the nerve; however, the complicated pattern of the nucleus ambiguus and the manifold fibers arising from its cells present a most complicated arrangement which accounts for the complex action of the various muscles which they innervate. Certainly the presentations of Drs. Lindsay and Morrison dealing with disturbed function point to the complex innervation referred to.

One slide which demonstrated degeneration of cells of origin of motor fibers of the recurrent laryngeal nerve was examined by experts at Parke, Davis & Company, who have been dealing with the effects of the viruses of poliomyelitis, and who confirmed without reservation the diagnosis of the type of degeneration one sees in the brain stem after section of the fibers.

The question of the nerve supply of the cricopharyngeus will sooner or later be definitely settled. Another item for further investigation relates to the difficulty of obtaining regeneration of the recurrent laryngeal nerve after end-to-end anastomosis or nerve graft. It is likely that it can be ascribed to the complicated pattern of the nucleus. The problem is to be able to follow the nerves in the process of regeneration all the way to their home base in the nucleus.

BLASTOMYCOSIS OF THE LARYNX.

WILLIAM C. THORNELL, M.D.

Dr. Thornell reports an unusual case of blastomycosis of the larynx in a man of 44, a butcher. The first biopsy was inconclusive; tuberculosis being suspected but not proven. Streptomycin and dihydrostreptomycin failed to afford any relief. The cords became progressively thickened and partially obstructing. A second biopsy preceding electrocoagulation of the cords yielded a hyperplastic mucosa containing some giant cells and spheroid bodies with refractile walls which were identified as

blastomyces. Some improvement followed the ingestion of iodides, but when the patient failed to maintain the therapy, the obstruction became more marked. Arytenoidectomy was performed on one side and then later on the other, affording considerable relief. With the resumption of iodide therapy the condition was brought to a standstill. Dr. Thornell suggests that the aromatic diamidines be employed in these cases, on the basis of some good reports following their use in blastomycosis in other areas. The case which he reported emphasizes the importance of bearing in mind the possibility of blastomycosis in any case of a granuloma of the larynx, once the more common lesions such as tuberculosis and carcinoma are excluded.

DISCUSSION.

DR. HOWARD W. D. MCCART showed slides of a case which was about to have a laryngectomy on the mistaken diagnosis of carcinoma. When viewed under low power 9 it did strongly suggest carcinoma; however, the high power was able to show the marked hyperplasia. The condition cleared up entirely within a few weeks under stilbamidine 150 mg.

DR. JAMES M. ROBB, commenting on the difficulty in diagnosing lesions of this sort, recalled the case of a woman of 40, who presented a small lump on the side of the neck which became red and tender. It was opened and drained and the material sent to the laboratory. Tuberculosis, histoplasmosis and blastomycosis were ruled out. The pathologist suggested cat scratch fever, and comparison with a report on this entity in the New England Medical Journal proved it. It is called nonspecific regional lymph adenitis, and in this case was cured by potassium iodide.

DR. LEWIS F. MORRISON inquired whether the organism shown in the cells in the slide presented were still present at the time of the arytenoidectomy.

DR. THORNELL replied that the organisms were found in the tissue at the time of the arytenoidectomy, even though the patient had had several courses of iodide therapy. It was difficult to keep the patient on the medication, but after complications developed he became more tractable and is reporting back frequently for observation.

LARYNGEAL PAPILLOMATA: SURGICAL TECHNIQUE FOR REMOVAL OF RECURRING AND OBSTRUCTIVE GROWTHS.

DEGRAAF WOODMAN, M.D.

DR. WOODMAN described a case of recurring laryngeal papillomata in an adult, which was cured by a thyrotomy and resection of the tumor bearing mucosa of the larynx which involved both cords and ventricular area. An acrylic mold was placed in the larynx attached to the tracheotomy tube and left *in situ* for eight weeks. When it was removed the operated area was seen to be completely healed and covered with normal appearing mucous membrane. One cord was immobile, and the other had some adductor function. The voice was a hard whisper adequate for the telephone; airway was sufficient, and function of the upper part of the glottis was active.

Since the operation two growths have been removed from the trachea, but the larynx has remained free.

The patient seemed to have a diathesis for mucosal pathology. She had undergone treatment for intramucosal carcinoma of the cervix and also was found to have papillomata in the bladder.

DISCUSSION.

DR. EDWIN N. BROYLES stated that generally speaking, thyrotomy is not indicated in these cases in children because of recurrences despite the surgery; however, if one is dealing with the adeno type of papilloma, one may be successful, because this type shows less tendency to recur. In Dr. Woodman's case where the growths were present in the trachea, it seems doubtful whether the results would be final. He certainly hoped Dr. Woodman would get away with it. It is true that through the laryngoscope one is unable to do a submucous resection of the growths, which is the secret of complete removal; therefore, the operation described by Dr. Woodman may have much more to offer.

DR. LEWIS F. MORRISON asked whether terramycin or aeromycin had been used pre- or postoperatively. They have in certain instances proved effective.

DR. MURDOCK S. EQUEN mentioned the case of a cheer leader who had been operated on a number of times in various clinics and finally developed a malignancy which necessitated a laryngectomy. It proves that these cases should not be taken lightly.

DR. FRED Z. HAVENS would not advise this procedure in children, but did think that in adults where the condition is more amenable they might benefit by it. Reference has been made to possible malignant changes. A patient on whom he had operated at the age of 12 or 13 had growths in the trachea which were pronounced malignant; yet the clinical course did not substantiate the diagnosis, since the patient kept having recurrences up to the age of 22 or 23 when last seen. A review of the earlier slides still classified them as malignancy; however, the patient is practically cured except for an occasional limited growth. The numerous operations led to a stenosis which Dr. Havens plans to correct with a skin graft. In this case a thyrotomy proved the inadequacy of removal under endoscopy, because of the inaccessibility of nodules deeply situated in the ventricles.

DR. WOODMAN concluded by stating that he had been hesitant about the procedure after hearing of failures elsewhere; however, the experience of many with implantation at the site of the surgical trauma impelled him to seek the more radical procedure in this case. Thus far the result has been good, it being already 14 months since the operation. She did have antibiotics at various times without result.

DR. Woodman recalled a discussion in which it was stated that removal of the growths followed by the application of podophyllin had been successful in preventing recurrence.

**DALLAS ACADEMY OF OPHTHALMOLOGY
AND OTOLARYNGOLOGY**

PROGRAM 1955 - 1956

Tuesday, December 6, 1955

3:00 P.M.—Program:

Streak Retinoscopy

Mr. Jack C. Copeland, Chicago, Illinois

Parkland Hospital—Doctor's Lounge

6:30 P.M.—Dinner, Parkland Hospital Dining Room

7:30 P.M.—Diagnosis in Rhinoplasty

Dr. Ralph H. Riggs, Shreveport, Louisiana

8:00 P.M.—Streak Retinoscopy Continued

**STANFORD UNIVERSITY SCHOOL OF MEDICINE
POSTGRADUATE COURSE.**

A Postgraduate Conference in Otorhinolaryngology will be presented by the Division of Otorhinolaryngology, Stanford University School of Medicine, March 26-30, 1956. This Conference will offer a comprehensive survey of the current field of Ear, Nose and Throat. Presentations will be didactic, by individuals and panel-groups. Some of the subjects will be: basic science reviews, such as anatomy (using three-dimensional projection) and pathology; audiology including psychogalvanic skin response; ear surgery, including stapes mobilization; nose and sinus problems, including rhinoplasty; pituitary surgery; allergy and steroid therapy; throat diseases including suspension laryngoscopy, laryngoplasty (*e.g.* use of tantalum plate), and laryngectomy with neck dissection; speech problems; bronchoscopy and esophagoscopy; etc.

Registration is limited to 30 Doctors of Medicine in E.N.T. or E.E.N.T., and the fee is \$100.00. Application may be made to: Office of the Dean, Stanford School of Medicine, 2398 Sacramento Street, San Francisco 15, California.

NATIONAL SOCIETY MEETINGS.

Schedule of Meetings for 1956:

American Laryngological, Rhinological, and Otological Society Inc.:

Eastern Section, to be held at the Statler Hotel, Boston, Mass., January 13.

Middle Section, to be held at the Netherlands Plaza, Cincinnati, Ohio, January 16.

Western Section, to be held at the County Medical Society Bldg., San Francisco, Calif., January 21.

Southern Section, to be held at the Shamrock, Houston, Texas, January 27-28.



American Board of Otolaryngology, to be held at the Sheraton-Mt. Royal, Montreal, Canada, May 6-11.

American Otological Society, Inc., to be held at the Seignior Club, Montreal, Canada, May 11-12.

American Laryngological Association to be held at the Seignior Club, Montreal, Canada, May 13-14.

American Broncho-Esophagological Association, to be held at the Sheraton-Mt. Royal, Montreal, Canada, May 15-16, (afternoons).

The American Laryngological, Rhinological and Otological Society, Inc., will hold its Annual Meeting at the Sheraton-Mt. Royal, Montreal, Canada, May 15-16-17 (mornings only).

Please make early plans to attend the 1956 Spring Meetings in Canada. Both the Seignior Club and Montreal present most attractive features for you and your family. More information about the places will be given later.

Reservations at the Sheraton-Mt. Royal Hotel should be made early by addressing the Reservation Supervisor, 1455 Peel Street, Montreal, P. Q., Canada.

COURSE IN RECONSTRUCTIVE SURGERY OF THE NASAL SEPTUM AND EXTERNAL PYRAMID.

Under the joint sponsorship of the Departments of Oto-Laryngology of the L.S.U. School of Medicine and Tulane School of Medicine a course in Reconstructive Surgery of the Nasal Septum and External Pyramid will be presented in New Orleans March 10-17 (inclusive), 1956.

The course will be given with the cooperation of the American Rhinologic Society and under the direction of Dr. Maurice H. Cottle.

The assisting guest faculty will include the following: Drs. Walter J. Aageson, Fred W. Beck, Max Bornstein, James Chesson, George G. Fischer, Irwin E. Gaynon, Harvey C. Gunderson, Richard B. Hadley, Robert Hansen, Kenneth H. Hinderer, John A. Kirschner, Walter E. Loch, Roland M. Loring, Joseph Ogura, Charles J. Puerillo, Ivan W. Philpott, Ralph H. Riggs, Pinckney W. Snelling, Carl B. Spath, Jr., and Russell I. Williams.

Applicants must be diplomates of the American Board of Oto-Laryngology. Class limited. Apply to: Dr. Clifford G. Grulee, Jr., Director of Graduate Medicine, School of Medicine, Tulane University, 1430 Tulane Avenue, New Orleans 12, Louisiana.





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